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CHAPTER TEN

SOURCES OF HOSPITAL COST VARIATION BY URBAN-RURAL LOCATION, TEACHING STATUS, AND BEDSIZE

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Prepared by

Janet B. Mitchell, Ph.D.
Kathleen A. Calore, M.A.
Jerry Cromwell, Ph.D.
Brooke Harrow, B.A.
Helene Hewes, B.S.

of

The Center for Health Economics Research

and

Lisa Iezzoni, M.D., M.S.
Health Care Research Unit
Section of General Internal Medicine
Boston University Medical Center

10.0 SOURCES OF HOSPITAL COST VARIATION BY URBAN-RURAL LOCATION, TEACHING STATUS, AND BEDSIZE

10.1 Introduction

As transition proceeds, three vital PPS policy issues continue to be hotly debated. The first concerns the urban-rural rate differential. After adjusting for hospital casemix, local area wages, and indirect teaching effects, a 25 percent average urban-rural cost differential remains, region by region.* The net effect is a PPS payment differential of a comparable amount, effectively sheltering more expensive urban hospitals in a major way. And while the regional rate differences are being phased out over four years, PPS will maintain the underlying urban-rural difference in perpetuity unless Congress is convinced that such protection is unnecessary or unjustified.

Teaching hospitals have also been receiving extra payments for "indirect medical education", or IME costs. The original adjustment, based on econometric estimates, was to be 5.8 percent of each hospital's federal rate, weighted by their resident-to-bed ratio. Congress elected to double the adjustment to assure continuing educational support. Subsequent analysis has shown large windfall gains for many teaching hospitals, however, prompting Congress to consider reducing the "double teaching" adjustment. The causes of the IME cost differential remain obscure, leaving teaching hospitals somewhat at the mercy of those seeking to cut budgets.

The third issue of bedsize and costs also remains enigmatic. Econometric regressions used to calibrate PPS included hospital bedsize (along with city size) to adjust for other left-out variables. Its inclusion materially reduced the casemix, wage index, and resident per bed coefficients, but because PPS makes no direct payment adjustment for bedsize, the PPS variables (and their coefficients) fail to fully reimburse average costs in many large hospitals. Hence, the bedsize issue is the converse of the urban-rural and teaching issues in that no adjustment is made in spite of econometric evidence to the contrary.

*The national urban-rural difference in PPS Standardized Adjusted Costs was 25.7 percent, ranging from a high of 29.1 percent West, North and South Central regions (Minnesota through Texas) to a low of only 7.3 percent in the mid-Atlantic region (Pennsylvania, New York, and New Jersey). Source: the Federal Register, June 10, 1985, Table 1.

The underlying sources of the observed cost differences are absolutely critical to formulating new policy. If they are the result of genuine casemix or severity differences, then higher costs may be justified on medical grounds alone. Similarly, if they arise from imperfectly measured labor input costs, then a wage index adjustment redresses the error. If, on the other hand, they are the result of systematic differences in practice styles that contribute little or nothing to ultimate patient outcomes, no adjustment may be warranted. These "style" differences could manifest themselves in greater procedural frequency or complexity or in simply keeping the patient in longer. Both are closely related to the final explanation, technical inefficiency, another clearly unjustifiable source of higher costs.

The rest of the Chapter is in four sections. Section 10.2 provides a detailed discussion of the research issues and the methods employed to address them. Most definitions and analytical methods have been described in the previous chapter. Section 10.2 provides more detail on the stepwise econometric method employed in explaining cost differences by urban-rural location, teaching status, and bedsize. Minor changes in the way procedures are measured are also discussed.

Sections 10.3 and 10.4 give the empirical results. Section 10.3 is descriptive, providing extensive cost and treatment comparisons across urban-rural, teaching, and bedsize strata. Section 10.4 then includes stepwise cost regressions, showing which variables contribute the most to the observed cost inequalities by stratum. As before, all analyses are done, however, using the individual admission as the unit of analysis.

A brief review of the key findings is provided in Section 10.5 at the end of the chapter.

10.2 Methods

10.2.1 Research Issues

Two approaches to the analysis were considered, depending on the policy questions to be addressed. One way to state the question is as follows:

- How much of observed cost difference between urban vs. rural areas, teaching vs. non-teaching hospitals, and large vs. small hospitals can be explained by systematic differences in input prices, casemix and severity, and practice styles or intensity?

If we are interested in explaining the observed cost differences, independent of the adjustments already incorporated into PPS, this requires an unconstrained regression model that allows the PPS coefficients (e.g., wage index) to vary in any way to maximize explanatory power. This is quite desirable for understanding the scope and influence of underlying factors. On the other hand, statements about the relative importance of input prices au naturel may not bear a close relation to their ability to reduce say, urban-rural disparities within a PPS framework.

By constraining the PPS coefficients, one could rephrase the research question in a subtle, but important, way:

- How much of the variation in urban-rural, teaching-nonteaching, and large-small hospital costs can be explained by input prices, casemix/severity, and practice styles using the PPS Standardized Allowable Cost (SAC) definition?

This would produce a narrower explanation of the 25 percent PPS urban-rural SAC differential rather than starting out with a much larger differential to explain. It would also shed more light on any remaining "biases" in PPS that have not been accounted for. Nevertheless, a SAC-specific approach was not taken in this chapter because of our broader interest in explaining why observed costs vary. By first developing a better understanding of underlying sources of cost differences, we hope to guide future research on how PPS could appropriately account for them.

A second reason for a more precise statement of the research question, one that explicitly states what is being held constant, arises from interactive, or joint, effects between two explainors. For example, if hospital casemix/severity happens to be greater in urban areas that also exhibit higher input prices, then our ability to isolate the severity from the wage impact is limited because part of the effect of one "loads" onto the effect of the other. Including only wage rates in the regression, for

example, will overstate its own explanatory power because it will include some severity adjustment as well. A hierarchical stepwise inclusion strategy can partially "solve" the problem if we choose to rephrase the research question as:

- How much of the observed urban-rural cost differential within-DRG is due to severity, say, holding interarea wages constant?

DRG casemix and the wage index would then be included first, with the marginal reduction in the urban-rural difference due to severity determined at the third step. This approach is only partially successful, however, because a part of the severity effect has already been picked up in the wage step.

Finally, while primary interest naturally is on the explanation of per admission costs, including length of stay (LOS) is a later step in the analysis allows us to distinguish between per day intensity vs. LOS effects on the observed cost differences. This allows us to restate the research question as:

- How much of the observed urban-rural cost difference within-DRG is due to intensity per day and how much to longer stays?

10.2.2 Stepwise Regression Method

Any patient's cost per admission (C/ADM) can be written as the product of average daily costs times length of stays:

$$\frac{C}{ADM} = \left[P_r \cdot \frac{I_r}{LOS} + P_a \cdot \frac{I_a}{LOS} \right] \cdot LOS \quad (10.1)$$

where P_r , P_a = average unit prices of routine (r) and ancillary (a) services, respectively; I_r , I_a = routine and ancillary inputs per stay; and LOS = the patient's length of stay. The term in brackets is the average per diem, inclusive of ancillary use, while the ratios, I_r / LOS and I_a / LOS , reflect real intensity per day (e.g., nursing services per day, x-rays per day).

Assuming that routine and ancillary input prices are proportional to the areawide hospital wage index, one can write the cost function in implicit form as

$$\frac{C}{ADM} = f(W, \frac{I_r}{r}, \frac{I_a}{a}, LOS). \quad (10.2)$$

Controlling only for wages, any unexplained (residual) cost variation can be attributed to either routine or ancillary per diem intensity or length of stay. If this residual is very large, we can conclude that little of the observed, or nominal, cost differences are due to interhospital differences in the prices they must pay for inputs but, rather, must be the result of real differences in practice styles, or intensity (either per day or via longer stays).

Intensity and length of stay, in turn, are logically determined by a set of patient illness characteristics, hospital characteristics, and physician practice patterns, as evidenced by differences in physician services. We are particularly concerned with the relative importance of these factors in explaining urban-rural, teaching, and bedsize differences.

To statistically determine the contribution of input prices, casemix/severity, and practice styles to differences in the strata of interest, stepwise regression is used on costs (in natural logs). All admissions within a tracer are pooled across the four states and after controlling for random state effects a simple urban-rural dummy entered, showing the gross percentage difference before any adjustments. Additional factors and covariates are then stepped in and the new urban-rural coefficient compared to the original, indicating the marginal reduction in the differences due to their inclusion. The general form of the equation is:

$$\begin{aligned} \ln(\text{MATOT}) = & \alpha_0 + \alpha_1 \text{STATE} + \alpha_2 U + \alpha_3 \text{DRG} + \alpha_4 \ln W \\ & + \alpha_5 \text{SEV} + \alpha_6 \text{PROC} + \alpha_7 \text{HOSP} \\ & + \alpha_8 \ln LOS + \alpha_9 \ln RDITEM + e \end{aligned} \quad (10.3)$$

where $\ln(\cdot)$ = natural logs; U = urban-rural dummy; MATOT = modified Part A costs (see section 10.2.3); DRG = a set of DRG dummies specific to the tracer; W = HCFA's 1981 (or 1984) hospital wage index; SEV = vector of staging and other casemix-related coefficients; PROC = vector of identified procedures performed on the patient; HOSP = vector of hospital characteristics; STATE = three dummy variables for patients in Washington, New Jersey, and Michigan (North Carolina patients are in the intercept); LOS = the patient's length of stay; and RDITEM = the hospital average post-stepdown routine costs per day, adjusted by the wage index.

The α_2 coefficient, properly adjusted,* gives the average percentage difference in Medicare cost per admission between urban and rural hospitals, holding the other included factors and covariates constant. If α_2 becomes insignificant (or even negative) after one or more covariates are included, we can conclude that no urban-rural difference remains beyond that explained by the included variables. (A negative coefficient could arise if, for example, urban hospitals were actually less expensive than rural hospitals once DRG mix, wages, and procedure intensity are held constant.)

Besides negative coefficients on the stratum variable of interest, it is also possible for the coefficient to increase as more variables are added to the stepwise regression. But how can adding another supposed cost explainer actually widen the gap, say, between urban and rural hospitals? This problem usually arises only for length of stay. Including length of stay can raise the urban-rural coefficient by essentially putting the cost comparison on a per day basis. It is reasonable to expect that urban hospitals have higher costs per day than per stay if they treat patients very intensively for shorter periods. The reader should always keep in mind the switch in dependent cost variate that implicitly occurs when LOS is entered into the regression.

Marginal changes in the urban-rural coefficient are generally sensitive to the order in which the variables are stepped in, making it impossible to exactly decompose the change by covariate. This is a standard problem arising from interactions that prevents a simple decomposition of the R^2 (Theil, 1971). For example, if $\alpha_2 = .50$ before entering any other variables and falls to .25 after including DRG dummies, we cannot simply conclude that DRG mix alone explains half the gross urban-rural difference. This is because DRG mix may be correlated with, say, the wage index (certain complicated cases may be treated systematically in high wage areas). If

*Researchers generally interpret dummy variable coefficients in semilogarithmic equations as arithmetic percentage differences. Halvoren and Palmquist (1980), however, demonstrate a bias using the unadjusted coefficients, which increases with the size of the difference. In fact, α_2 is an estimate of $\alpha_2 = \ln(1+g)$. Where 100g is the correct percentage difference. Exponentiating and solving for g give $g = \exp(\alpha_2) - 1$. For $\alpha_2 = .05$, $g = .0513$, a trivial difference, whereas for $\alpha_2 = .50$, $g = .649$. All dummy coefficients discussed below are therefore transformed into simple arithmetic differences using $g = \exp(\alpha) - 1$.

this were the case, a 50 percent reduction in the urban-rural coefficient is due to wage as well as DRG effects, even though wages have not been explicitly controlled for. Moreover, if wages were controlled for first, its cost-reducing effect would be greater than when included after DRG mix, for similar reasons. The DRG mix effect, by the same reasoning, would be much smaller.

Indeed, wages present a special problem in our attempt to assign explanatory power to the covariates because economic theory places an upper limit on the effect. If wages double and labor is 80 percent of hospital costs, then costs can only increase 80 percent at most, ceteris paribus. Unconstrained regressions of eq. (10.3) with the wage index on the right-hand-side produced regression coefficients ranging as high as 1.7, implying a 170 percent increase in costs where wages were twice as high. To address this problem, we deflated the dependent cost variable by $(W)^{.8}$ after the first stage with only the urban-rural (teaching, or bedsize) dummy included. The change in the dummy coefficient thus shows the reduction in the urban-rural gap for a properly constrained wage effect. The remaining covariates are then stepped in, giving their marginal contribution to costs, holding wage differences constant.

Because PPS makes explicit adjustments for DRG mix and wages, it seems logical to enter these variables first, beginning with the wage adjustment described above. By entering DRG mix next, the effects on α_2 of including other variables like severity and procedure mix in later steps can then be interpreted as "within-DRG".

10.2.3 Specification of Costs and Procedures

The definitions and adjustments to costs have already been described in detail in the previous chapter. Summarizing, four costs are analyzed: (1) Medicare Part A-only per admission (ATOT); (2) Medicare Part A plus all Part B radiology, anesthesiology, pathology, and ECG reasonable costs per admission (MATOT); (3) all Part A and B costs incurred during the admission (ABTOT); and (4) modified (MATOT) costs per day. All descriptive cost tables present the data adjusted by the area wage index to put the numbers in real terms. Hence, if a group of hospitals exhibit Part A costs twice those of another group, we can be fairly confident that the difference is not because the former are operating in high wage cities. (See previous chapter for more details.)

Three substantive changes in the way procedures were accounted for in the previous chapter have been made. First, the list of included procedures in each DRG cluster has been expanded slightly to include other, less clinically related, procedures. We felt this would better control for the range of diagnostic and therapeutic activity afforded patients in different hospitals. The following procedures, by cluster, were added to the basic list presented in Table 9-2 in the previous chapter.

CARDIAC: (1) Chest x-rays, (2) ECGs, (3) barium enemas, (4) radionuclide pulmonary ventilation and perfusion scans, (5) cardiac resuscitation;

CEREBROVASCULAR: (1) Chest x-rays, (2) ECGs, (3) spine x-rays, (4) barium enemas, (5) abdomen x-rays;

PROSTATE: (1) Chest x-rays, (2) ECGs, (3) radiation therapy;

PNEUMONIA: (1) ECGs, (2) barium enemas, (3) abdomen x-rays.

Second, many of the procedures were analyzed as continuous rather than discrete, 0-1, variables to account for the intensity, or repetitiveness, of activity. Care must be taken, of course, not to double count procedures because of multiple physician billing of a single procedure. In determining

whether a particular procedure was performed at all during the admission, we pooled cardiologist, assistant surgeon, radiologist, and anesthesiologist bills and set the procedure equal to one if any of these (or other) physicians submitted a bill. In the few cases where multiple billing for different parts of the same procedure is common, we continued to use the 0-1 approach, e.g., echocardiography.

Third, to account for the wide range in other, seemingly unrelated, procedures appearing as Part B charges, we included (in logs) a residual Part B charges covariate. The residual was calculated by subtracting the charges associated with all the included procedures from total Part B charges, then deflating by the wage index to put the figure in real terms. The result is a net real Part B figure that can be considered a proxy for intensity differences across patients (and hospitals) not captured explicitly in our procedure list.

10.2.4 Specification of the Urban-Rural, Teaching, and Hospital Size Strata

To carry out the comparative cost analysis, the key urban-rural, teaching, and bedsize strata must be specified, or defined. PPS variables will be used with the following thresholds:

- (1) A hospital will be considered to be in an urban area if in a Metropolitan Statistical Area (MSA), as defined in PPS;
- (2) Major vs. minor teaching hospitals will be defined as those having more or less than 25 residents per 100 beds while nonteaching hospitals are those reporting no residents on staff; and
- (3) Large vs. medium-sized hospitals are defined as having more or less the 400 total beds while hospitals are considered small if less than 100 beds.

Metropolitan Statistical Areas are currently in use in PPS. All New Jersey hospitals are in an MSA, however, giving no urban-rural split. Yet, many are geographically remote from a large urban center like Newark. To better test the urban-rural difference, a core-ring MSA approach is also employed. For hospitals in the 100 largest cities in the U.S., a "core" MSA distinction is made. Remaining hospitals in the MSA but not in the central

city per se are placed in the outer "ring". Any hospitals in an MSA not containing a large city are further distinguished as "other MSA".

Trichotomizing the urban definition permits a test of the hypothesis that urban-rural differences are primarily, if not totally, the product of large, inner city differences; that suburban hospitals are little different from rural hospitals.

Ten cities comprise the large city MSA core in the four states: (1) Detroit, Michigan; (2) Grand Rapids, Michigan; (3) Flint, Michigan; (4) Seattle, Washington; (5) Spokane, Washington; (6) Tacoma, Washington; (7) Newark, New Jersey; (8) Jersey City, New Jersey; (9) Charlotte, North Carolina; (10) Greensboro, North Carolina. All other hospitals in these MSAs are considered "ring" while all hospitals in an MSA without one of these core large cities are considered OtherMSA.

The trichotomy also permits a more refined measure of the wage index. Under PPS, all hospitals in an MSA are given the same index value. Our investigation also tests wage effects on urban-rural, teaching, and bedsize strata when the index is based on core-ring-other MSA differences. If core city hospitals are more costly in part because they pay higher wages than suburban MSA hospitals, the revised wage index should explain more of the MSA-nonMSA difference than the PPS index which recognizes no such wage difference.

PPS also bases the indirect teaching allowance on the hospital's intern-resident-per-bed ratio. Following other HCFA research, large teaching institutions are defined as having at least 25 residents per 100 beds, using 1981 figures. Many teaching hospitals do not meet the 25-per-100 criterion because of their size. An 800 bed hospital, for example, must have at least 200 residents. Very few meet the threshold in the four-state sample (only 12 of 106 teaching hospitals are "major"; see previous chapter) although they account for a disproportionate number of the tracer admissions because of their absolute size.

Because PPS makes no direct adjustment for bedsize, no regulatory thresholds exist.* We have used a trichotomization of less-than-100 (small), 100-to-400 (medium), and over-400 beds (large) for two reasons. First, previous research suggests that under-100 bed hospitals exhibit very different input and cost structures from the rest of the industry. Second, while an even higher threshold is preferable for "truly large" hospitals, small sample sizes required relaxing the criterion to 400 and above.

Table 10-1 gives a decomposition of the hospital sample by state urban-rural location, teaching status, and by bedsize.

TABLE 10-1

DISTRIBUTION OF SAMPLE HOSPITALS BY STATE, URBAN-RURAL, TEACHING STATUS, AND BEDSIZE

	Rural	Other MSA	Ring	Core	Total
Michigan	77	2	65	50	194
N. Carolina	78	6	20	24	128
New Jersey	0	34	45	16	95
Washington	49	3	19	31	102
TOTAL	204	45	149	121	519
Non-teaching	200	29	110	53	392
Minor Teaching	4	16	34	61	115
Major Teaching	0	0	5	7	12

Bedsize	Non Teaching	Minor Teaching	Major Teaching	Total
<100	199	6	1	206
100-400	183	58	3	244
400+	10	51	8	69
TOTAL	392	115	12	519

Notes: CORE = hospitals in the 100 largest cities in the United States;
 RING = hospitals in the suburban rings around the central city cores;

Other MSA = hospitals in MSAs without a city in the top 100.
 Minor Teaching = an intern/resident per bed ratio less than .25;
 Major Teaching = an intern/resident per bed ratio above .25.

10.3 Descriptive Results by Urban-Rural, Teaching, and Bedsize Strata

This section reports comparative differences in costs for three hospital strata: urban-rural location, teaching status, and by bedsize. Each subsection is further divided into three parts. First, we compare cost and utilization differences, then casemix and severity differences, and conclude with procedure mix comparisons.

10.3.1 Urban-Rural Comparisons

Urban-Rural Differences in Costs and Lengths of Stay

Table 10-2 compares costs and lengths of stay, first, between rural and urban (MSA) areas (in columns 1 and 2), then within urban areas, among large core cities, their suburban rings, and other MSAs without a major city. All costs are deflated by the PPS wage index, improving comparability.

Admissions by area are included in parentheses.

Even after deflation, urban Part A adjusted average costs per admission (line 2) ranged from 13 (prostate) to 61 (coronary artery disease CAD) percent higher than in rural areas. Longer lengths of stay in urban areas explain 1/3-1/2 of the gap, see line 4, except for prostate cases where LOS appears to be the sole reason. The strong urban bias towards the surgical DRGs 106 and 107 undoubtedly explains some of the remainder for CAD.

Differences are clearly not the same across urban areas. Big core cities are invariably much more expensive than either suburban rings or small MSAs. CAD cases are the extreme example with deflated costs of \$3,898 vs. \$2,125 in other MSAs and only \$1,874 in rural areas. Big city hospitals, in fact, are 60 percent more costly than those in the surrounding suburban ring (\$3,898/\$2,424). Interestingly, the within-MSA gap is not due to systematic LOS differences. In all four tracers, the within-MSA length of stay is similar or shorter in the central core.

Departments accounting for the urban-rural gap naturally vary by tracer, but radiology and lab costs usually show the most urban-rural disparity, e.g., 50-90 percent higher in urban areas. Miscellaneous costs are also dramatically different in all but the prostate cluster, a fact examined in the next section. Also note the large difference in operating room (OR) costs for CAD, reflecting the higher frequency of heart bypass operations in urban areas (discussed below).

*Five hundred beds were originally used to define rural referral centers, but the criterion was discarded because only 4-5 hospitals met the condition.

TABLE 10-2

URBAN-RURAL COST DIFFERENCES: CORONARY ARTERY DISEASE

(Number of cases)	Rural (14,518)	Urban (44,498)	Core City (19,409)	Suburban Ring (18,345)	Other MSA (6,744)
Part A Cost	\$1,791	\$2,870	\$3,677	\$2,315	\$2,057
Part A (ADJ) Cost	1,874	3,021	3,898	2,424	2,125
Part A and B Cost	2,134	3,682	4,827	2,883	2,560
Part A (ADJ) Cost Per Day	252	327	415	267	239
Routine Costs	870	1,056	1,141	1,024	898
ICU Costs	266	492	639	353	447
OR Costs	13	136	257	52	12
Radiology (ADJ) Costs	121	233	332	167	132
Anesthesia (ADJ) Costs	7	58	107	23	10
Lab Costs	202	311	375	267	246
Miscellaneous Costs	390	731	1,038	536	379
Length of Stay (days)	8.1	9.5	9.5	9.5	9.4
Percent in ICU (%)	35.0	37.7	40.0	33.2	43.3
LOS in ICU (days)	2.5	3.4	3.7	3.0	3.3

URBAN-RURAL COST DIFFERENCES: CEREBROVASCULAR DISEASE

	Rural (10,530)	Urban (39,161)	Core City (15,533)	Suburban Ring (16,418)	Other MSA (7,210)
Part A Cost	\$2,167	\$3,036	\$3,316	\$2,910	\$2,717
Part A (ADJ) Cost	2,279	3,217	3,525	3,082	2,860
Part A and B Cost	2,605	3,777	4,085	3,629	3,449
Part A (ADJ) Cost Per Day	227	260	298	239	225
Routine Costs	1,261	1,667	1,716	1,638	1,630
ICU Costs	101	164	184	139	181
OR Costs	26	66	89	54	42
Radiology (ADJ) Costs	190	296	376	261	204
Anesthesia (ADJ) Costs	16	42	54	38	28
Lab Costs	162	237	247	234	220
Miscellaneous Costs	518	744	859	717	556
Length of Stay (days)	11.3	13.8	13.2	14.2	14.3
Percent in ICU (%)	11.7	13.4	13.5	11.9	16.4
LOS in ICU (days)	2.8	3.4	3.4	3.4	3.5

Sources: Medicare Part A and Part B claims, 1982

Note: All dollar figures deflated by PPS wage index. Number of admissions in parentheses.

TABLE 10-2 (continued)

URBAN-RURAL COST DIFFERENCES: PNEUMONIA DISEASE

	Rural (7,352)	Urban (17,243)	Core City (6,678)	Suburban Ring (7,361)	Other MSA (3,204)
Part A Cost	\$2,465	\$3,345	\$3,731	\$3,150	\$2,990
Part A (ADJ) Cost	2,538	3,432	3,829	3,233	3,061
Part A and B Cost	2,796	3,848	4,237	3,645	3,508
Part A (ADJ) Cost Per Day	240	268	299	253	236
 Routine Costs	1,268	1,597	1,710	1,515	1,550
ICU Costs	81	188	194	175	207
OR Costs	8	18	23	17	12
Radiology (ADJ) Costs	155	203	251	180	158
Anesthesia (ADJ) Costs	3	9	10	8	7
Lab Costs	214	359	392	350	310
Miscellaneous Costs	804	1,055	1,244	987	817
 Length of Stay (days)	10.9	13.1	12.9	13.0	13.7
Percent in ICU (%)	6.9	10.0	9.4	9.4	12.5
LOS in ICU (days)	4.0	5.2	4.9	5.4	5.2

URBAN-RURAL COST DIFFERENCES: PROSTATE DISEASE

	Rural (4,382)	Urban (17,120)	Core City (7,763)	Suburban Ring (6,907)	Other MSA (2,450)
Part A Cost	\$2,217	\$2,510	\$2,710	\$2,373	\$2,260
Part A (ADJ) Cost	2,418	2,728	2,935	2,587	2,469
Part A and B Cost	3,300	3,683	3,849	3,548	3,537
Part A (ADJ) Cost Per Day	276	275	295	262	245
 Routine Costs	1,064	1,280	1,377	1,194	1,213
ICU Costs	27	36	38	29	48
OR Costs	323	367	388	357	326
Radiology (ADJ) Costs	144	169	202	147	130
Anesthesia (ADJ) Costs	183	202	214	200	172
Lab Costs	180	214	214	224	189
Miscellaneous Costs	486	454	493	433	390
 Length of Stay (days)	9.1	10.3	10.2	10.3	10.6
Percent in ICU (%)	4.2	3.4	2.8	4.1	3.7
LOS in ICU (days)	2.2	2.9	3.3	2.2	4.1

Sources: Medicare Part A and Part B claims, 1982

Note: All dollar figures deflated by area wage index. Number of admissions in parentheses.

Urban-Rural Differences in Casemix-Severity

The DRG casemix analysis by cluster yields one striking finding: urban cases receive consistently more surgical procedures than their rural counterparts. The other results support the general trend but are less dramatic. Urban cases possess a slightly higher proportion of complex diagnoses, are slightly older, and are slightly more likely to die in the hospital than rural cases. These results suggest that urban cases may be more severely ill than rural cases, but the casemix measures used in this analysis fail to yield remarkable differences between the two groups.

The surgical finding is most apparent in the CAD cluster (see Table 10-3). Of cases admitted in this tracer, 6.5% receive coronary artery surgery (DRGs 106 and 107) in urban hospitals (see last column) compared to only 0.7% in rural hospitals. Adding cardiac catheterization (DRG 125), the percentage of cases receiving some major procedure is 19.8% in urban areas compared to only 3.3% in rural areas, a 6-to-1 difference. Similarly, 7.3% of cerebrovascular (CVD) cases in urban hospitals receive extracranial vascular procedures (DRG 5) compared to 3.5% of rural cases. Prostate surgery, which is generally more common, shows far less variation: 78.2% of urban cases receive prostate surgery (DRGs 306, 307, 336, 337) compared to 73.2% of rural cases.

Medical admission patterns reveal slightly greater frequency of complex diagnoses in urban compared to rural hospitals. In the pneumonia DRGC, 9.0% of urban cases fall into the more serious respiratory infections (DRGs 79, 80, and 81) compared to 7.7% of rural cases. Across the prostatic disease DRGC, a higher proportion of rural cases (16.5%) were admitted for medical treatment of cancer than urban cases (14.1%), but the proportion of medical admissions with malignant cancer was slightly higher in urban areas. One finding points in the opposite direction. In the CVD cluster, rural hospitals had relatively more admissions for stroke (DRG 14) than TIAs (DRG 15).

Comparing DRG pairs split on the basis of age 70 and comorbidity failed to yield a consistent pattern. In CAD, urban cases fall disproportionately into the older, complicated atherosclerosis DRG 132 (versus 133) compared with rural cases. The same pattern holds for similar comparisons in the pneumonia cluster (DRG 79/DRG 80 and DRG 89/DRG 90). Contradictory results arise in both medical prostate groups (cancer and benign hypertrophy). In rural areas, 88.4% of medical prostate cancer cases fall into the more

TABLE 10-3

DRG MIX BY URBAN RURAL LOCATION BY STATE CLUSTER

	<u>Michigan</u>		<u>North Carolina</u>		<u>New Jersey</u>		<u>Washington</u>		<u>All Four States</u>	
	<u>Rural</u>	<u>Urban</u>	<u>Rural</u>	<u>Urban</u>	<u>Rural</u>	<u>Urban</u>	<u>Rural</u>	<u>Urban</u>	<u>Rural</u>	<u>Urban</u>
<u>CORONARY ARTERY DISEASE</u>	(n=4,647)	(n=16,236)	(n=8,325)	(n=7,552)	(n=15,670)	(n=1,561)	(n=5,028)	(n=14,518)	(n=44,498)	
106 Coro bypass w/Cardiac Cath.	0.6%	1.4%	0.0%	5.4%	0.9%	0.6%	12.5%	0.3%	3.2%	
107 Coro bypass w/o Cardiac Cath.	0.5	4.1	0.1	2.0	1.4	1.0	8.7	0.4	3.3	
125 Circ dia w C.C. w/o comp.	4.4	11.8	1.5	18.6	11.2	3.0	16.5	2.6	13.3	
132 Athero > 69 and/or C.C.	37.1	28.6	43.6	27.4	15.0	20.3	12.0	39.1	21.7	
133 Athero < w/o C.C.	6.7	7.1	16.1	10.3	3.9	1.9	1.0	11.5	5.8	
140 Angina Pectoris	39.7	37.2	29.3	24.8	60.1	53.2	33.4	35.2	42.7	
143 Chest Pain	11.0	9.8	9.4	11.5	7.6	20.1	16.0	11.0	10.0	
<u>CEREROVASCULAR DISEASE</u>	(n=3,241)	(n=13,287)	(n=5,794)	(n=5,557)	(n=1,5720)	(n=1,511)	(n=4,583)	(n=9,454)	(n=38,817)	
5 Extracranial Vasc Proc	2.4	7.2	2.7	8.0	5.1	9.1	18.4	3.5	7.3	
14 Spec Cerebro Dis exc. TIA	52.8	46.7	59.6	60.0	52.0	56.1	53.4	57.3	52.1	
15 TIA	33.2	33.7	26.0	22.6	35.5	28.3	23.2	28.4	31.9	
16 NonSpec Cerebro Dis w C.C.	1.8	1.6	0.0	0.0	1.8	3.2	2.4	0.8	1.6	
17 NonSpec Cerebro Dis w/o C.C.	9.8	8.9	11.7	9.7	5.5	3.4	2.4	10.0	7.1	
<u>PNEUMONIA</u>	(n=2,318)	(n=5,642)	(n=3,889)	(n=2,807)	(n=6,571)	(n=1,158)	(n=2,210)	(n=6,529)	(n=17,307)	
79 Resp Infect+Infl >69 +/or C.C.	3.5	7.0	7.1	7.8	6.1	9.4	13.9	6.3	7.3	
80 Resp Infect+Infl 18-69 w/o C.C.	1.0	1.1	1.9	2.6	1.4	0.6	0.7	1.4	1.5	
81 Resp Infect+Infl 0-17	0.0	0.0	0.0	0.0	0.6	0.0	0.1	0.0	0.2	
89 Simp Pneu+Pleur >69 +/or C.C.	77.1	76.2	70.3	69.0	72.4	82.1	79.2	74.1	73.8	
90 Simp Pneu+Pleur 18-69	18.0	15.2	20.8	20.6	12.8	7.5	5.8	18.1	14.3	
91 Simp Pneu+Pleur 0-17	0.4	0.5	0.0	0.0	6.8	0.4	0.2	0.2	2.8	
<u>PROSTATE DISEASE</u>	(n=1,489)	(n=6,317)	(n=2,161)	(n=2,746)	(n=5,688)	(n=732)	(n=2,369)	(n=4,382)	(n=17,320)	
306 Prost >69+/or C.C.	12.3	11.5	2.6	2.9	8.6	11.9	6.8	7.4	8.5	
307 Prost < 70 w/o C.C.	4.3	3.9	1.1	1.1	2.3	2.0	1.4	2.4	2.6	
336 TURP >69+/or C.C.	45.4	44.7	47.6	52.0	50.0	57.7	66.1	48.5	50.6	
337 TURP < 70 w/o C.C.	13.8	16.0	17.1	18.9	16.6	10.8	14.8	14.9	16.5	
346 Cancer Repro. >69+/or C.C.	12.6	13.1	16.3	15.2	11.0	13.5	8.1	14.6	12.0	
347 Cancer Repro < 70 w/o C.C.	2.4	2.5	2.1	2.8	1.9	0.4	0.8	1.9	2.1	
348 Benign Pros Hyper >69+/or C.C.	7.7	6.2	9.7	5.0	7.4	3.0	1.9	7.9	5.8	
349 Benign Frost Hyper < 70 w/o C.C.	1.5	2.2	3.6	2.0	2.3	0.7	0.2	2.4	1.9	

Source: Medicare Part A and Part B claims, 1982.

complicated DRG 346 versus 347, compared to 85.1% of urban cases. In the data base used for this analysis, the majority of assignments within DRG pairs are based on age not secondary diagnosis. Thus, these comparisons reveal more about the age of cases across rural and urban hospitals than about the presence or absence of comorbidity.

Further decomposing the urban-rural casemix differences by type of urban area (see Table 10-4) highlights how concentrated some DRGs are. The surgical cardiac DRGs 106 and 107 are the most concentrated. Almost 1-in-8 cardiac patients in large core city hospitals undergo heart bypass surgery vs. 1-in-53 in their surrounding suburban hospitals, and just 1-in-142 in small MSAs and in "rural" hospitals. Core city hospitals also have much higher frequencies (18 percent) of DRG 125 (Circulatory Disorders); DRG 5 (Extracranial vascular procedures, 10.1 percent of the cerebrovascular cluster); and DRG 79 (Respiratory infections over age 70 or with complications, 9.2 percent of pneumonia patients). Except for these few DRGs, within-urban DRG mix differences are minimal.

The age distribution of patients was pursued by examining the percentage of frail elderly in eight DRGs (see Table 10-5). In half of these, the differences between urban and rural hospitals were one percentage point or less. In the remaining four, urban hospitals had a higher fraction of "old old" cases in three. In the one exception, TIAs (DRG 15), 17.8% of rural cases were over 85 compared to 14.7% of urban cases. These results suggest that urban cases are slightly older than rural cases within DRG, but the differences are very slight.

Similar results obtain using death as a severity criterion. In seven DRGs, urban hospitals had a higher death rate while in the eighth (DRG 346), the death rate was slightly higher in rural hospitals. However, in five of the seven cases, the urban within-hospital death rate was less than one percentage point higher than the rural rate. The two cases where important differences occurred were both in the pneumonia DRGC: in DRG 79, 21.4% of urban cases died in the hospital compared to "only" 16.0% of rural cases; in DRG 89, 14.1% of urban cases died compared to 10.1% of rural cases. Thus, using death as an indicator of disease severity, urban pneumonia cases appear "sicker" than those in rural areas, but only for this cluster. It is also not clear whether the death rates are an artifact of urban preferences to remain in the hospital -- possibly receiving more aggressive care.

Turning to the finer-grained results based on diagnostic mix and staging, the comparisons are fairly limited (see Tables 10-6 and 10-7). In most cases, a single disease dominated the entire DRGC in both urban and

TABLE 10-4

DRG MIX BY CORE-RING-OTHER MSA VS. RURAL AREAS BY CLUSTER

	<u>1</u> <u>Core City</u>	<u>2</u> <u>Suburban Ring</u>	<u>3</u> <u>Other MSA</u>	<u>4</u> <u>Rural</u>
CORONARY ARTERY DISEASE	(n=19,409)	(n=18,345)	(n=6,744)	(n=14,518)
106 Coro bypass w/Cardiac cath.	6.2%	1.0%	0.1%	0.3%
107 Coro bypass w/oCardiac cath.	6.5	0.9	0.6	0.4
125 Cire dis w C.C. w/o comp.	18.0	9.2	10.7	2.6
132 Athero > 69 and/or C.C.	21.4	25.7	12.0	39.1
133 Athero < w/o C.C.	6.2	6.5	2.8	11.5
140 Angina Pectoris	31.3	47.8	62.0	35.1
143 Chest Pain	10.4	8.9	11.7	11.0
CERBROVASCULAR DISEASE	(n=15,533)	(n=16,418)	(n=7,210)	(n=10,530)
5 Extracranial Vasc Proc	10.1%	6.2%	6.4%	3.5%
14 Spec Cerebro Dis exc. TIA	52.2	51.6	53.6	57.0
15 TIA	28.9	33.2	33.9	28.5
16 NonSpec Cerbro Dis w C.C.	1.7	1.4	1.6	1.0
17 NonSpec Cerbro Dis w/o C.C.	7.3	7.6	4.5	10.0
PNEUMONIA	(n= 6,678)	(n=7,361)	(n=3,204)	(n=7,352)
79 Resp Infect+Infl >69 +/or C.C.	9.2%	7.1%	5.7%	6.3%
80 Resp Infect+Infl 18-69 w/o C.C.	1.7	1.4	1.1	1.4
81 Resp Infect+Infl 0-17	0.2	0.3	0.4	0.0
89 Simp Pneu+Pleur >69 +/or C.C.	72.9	73.6	77.0	74.3
90 Simp Pneu+Pleur 18-69	14.5	14.2	12.0	17.9
91 Simp Pneu+Pleur 0-17	1.5	3.4	3.9	0.2
PROSTATE DISEASE	(n= 7,763)	(n=6,907)	(n=2,450)	(n=4,382)
306 Prost >69+/or C.C.	9.1%	8.4%	6.9%	7.4%
307 Prost < 70 w/o C.C.	2.8	2.7	1.7	2.4
336 TURP >69+/or C.C.	50.8	49.9	51.9	48.5
337 TURP < 70 w/o C.C.	16.4	16.8	16.2	14.9
346 Cancer Repro. >69+/or C.C.	12.8	11.2	11.9	14.6
347 Cancer Repro. < 70 w/o C.C.	2.2	2.0	2.1	1.9
348 Benign Pros Hyper >69+/or C.C.	4.3	6.9	7.4	7.9
349 Benign Prost Hyper < 70 w/o C.C.	1.7	2.1	1.9	2.4

Sources: Medicare Part A and Part B claims, 1982

TABLE 10-5

PERCENT FRAIL ELDERLY AND EXPIRED BY URBAN-RURAL LOCATION, SELECTED DRGS

DRG	Description	Percent Above ^a Age Cut-off		Percent Died	
		Rural	Urban	Rural	Urban
<u>Cerebrovascular Disease Cluster</u>					
14	Specific Cerebrovascular Disorders Except TIA	15.1%	15.9%	17.7%	18.0%
15	Transient Ischemic Attacks	17.8	14.7	0.7	1.5
<u>Pneumonia Cluster</u>					
79	Respiratory Infections + Inflammation Age >69 and/or C.C.	38.2	38.5	16.0	21.4
89	Simple Pneumonia + Pleurisy Age >69 and/or C.C.	38.3	43.9	10.1	14.1
<u>Coronary Artery Disease Cluster</u>					
132	Atherosclerosis Age >69 and/or C.C.	17.2	18.4	5.8	6.7
140	Angina Pectoris	7.1	6.9	0.5	1.3
<u>Prostate Disease Cluster</u>					
336	Transurethral Prostatectomy Age >69 and/or C.C.	26.0	26.4	0.6	0.9
346	Malignancy, Male Reproductive System, Age >69 and/or C.C.	26.3	28.3	17.6	16.7

^aAge cut-off = 80 for DRGs 79, 89, 336, 346.
85 for DRGs 14, 15, 132, 140.

Source: Medicare Part A and Part B claims, 1982.

rural location. Some results have interest nevertheless. Nearly identical fractions of TURP (DRG 336) cases had cancer in both areas. In rural hospitals, a higher percent of DRG 79 cases had tuberculosis (15.8%) compared to urban hospitals (13.9%). This finding is probably driven by the large number of tuberculosis cases in North Carolina, a largely rural state. North Carolina also probably causes the difference in disease distribution observed in TIAs (DRG 15). "Disease of Basilar Artery" occurs in 25.7% of rural cases compared to 9.6% of urban cases, but as noted in the previous chapter this is an artifact of North Carolina's diagnostic coding practices. "Disease of Basilar Artery" occurs in 50.9% of North Carolina DRG 15 cases, compared to 5.5% in New Jersey, 5.0% in Washington, and 3.8% in Michigan.

The staging outcomes for the most common diseases in the eight DRGs are presented in Tables 10-7. As expected from the preceding discussion, urban cases in Disease 504, "Bacterial Pneumonia", fall into Stage 4, death, (15.5%) more than rural cases (11.0%). In most cases, however, the distribution across stages is quite similar between urban and rural hospitals. One exception is that more urban (17.2%) than rural cases (10.0%) fall into Stage 3 of Disease 1001, "Prostate Cancer" (DRG 346), but more rural cases (17.0) die than urban cases (15.9%).

In summary, the casemix analysis across urban and rural hospitals is suggestive but certainly not definitive. Urban admissions may be somewhat older and "sicker" than rural cases, but the differences are by no means dramatic. The only striking finding arose in examining the DRG mix within clusters: urban patients are definitely more likely to receive major surgery than their rural counterparts, a fact that is accounted for by DRG-specific payments.

Urban-Rural Differences in Within-DRG Procedure Mix

The eight DRGs examined in detail yield a very simple and consistent message: urban cases receive far more services and procedures than rural cases (see Table 10-8). Procedure mix in urban hospitals also appears somewhat more sophisticated, although the differences are not nearly as marked as in the teaching status analysis to follow.

The urban technology bias is most marked in the CVD examples -- stroke (DRG 14) and TIAs (DRG 15). Urban stroke cases about 2 1/2 times more likely than their rural counterparts to obtain the expensive, relatively new

TABLE 10 6

COMMON STAGING DISEASE ASSIGNMENTS WITHIN DRG BY URBAN-RURAL LOCATION

DRG	Description	Disease Name and Number	Percent of Cases	
			Rural	Urban
CEREBROVASCULAR DISEASE CLUSTER				
14	Specific Cerebrovascular Disorders Except TIA	Disease of Carotid Artery (251) Aneurysm of Cerebral Vessels (253) Disease of Vertebral Artery (254) Atrial Fibrillation (817) Essential Hypertension (829)	0.5% 5.0 88.8 1.0 3.9	0.7% 5.6 85.0 1.1 6.6
15	Transient Ischemic Attacks	Disease of Carotid Artery (251) Disease of Basilar Artery (252) Disease of Vertebral Artery (254)	72.4 25.7 1.8	86.0 9.6 4.0
PNEUMONIA CLUSTER				
79	Respiratory Infections + Inflammation Age >69 and/or C.C.	Anaerobic Infections (411) Bacterial Pneumonia (504) Tuberculosis (514) Other Respiratory Conditions (590)	10.4 33.1 15.8 28.1	10.5 28.4 13.9 30.7
89	Simple Pneumonia + Pleurisy Age >69 and/or C.C.	Bacterial Pneumonia (504) Other Respiratory Conditions (590)	90.4 2.3	90.6 1.6
CORONARY ARTERY DISEASE CLUSTER				
132	Atherosclerosis Age >69 and/or C.C.	Acute Myocardial Infarction (811) Atherosclerosis of Coronary Arteries (815)	0.0 95.7	0.1 91.9
140	Angina Pectoris	Atherosclerosis of Coronary Arteries (815)	99.8	99.4
PROSTATE DISEASE CLUSTER				
336	Transurethral Prostatectomy Age >69 and/or C.C.	Prostate Cancer (1001) Benign Prostatic Hypertrophy (1008)	23.4 72.9	23.8 73.4
346	Malignancy, Male Reproductive System, Age >69 and/or C.C.	Prostate Cancer (1001)	95.8	96.0

Note: Disease assignments and numbers based on Systemetrics staging algorithms.

TABLE 10-7
STAGING ASSIGNMENTS WITHIN THE MOST COMMON STAGED DISEASE CATEGORY BY URBAN-RURAL LOCATION

DRG	Description	Disease Name and Number	Stage ^a	Percent of Cases	
				Rural	Urban
Cerebrovascular Disease Cluster					
14	Specific Cerebrovascular Disorders Except TIA	Disease of Vertebral Artery (254)	1	0.0%	0.0%
			2	82.2	81.6
			3	0.1	0.2
			4	17.7	18.3
15	Transient Ischemic Attacks	Disease of Carotid Artery (251)	1	96.5%	96.2%
			2	2.9	2.5
			3	0.1	0.0
			4	0.5	1.4
Pneumonia Cluster					
79	Respiratory Infections + Inflammation Age >69 and/or C.C.	Bacterial Pneumonia (504)	1	83.0%	72.2%
			2	2.0	3.7
			3	1.3	2.4
			4	13.7	21.7
89	Simple Pneumonia + Pleurisy Age >69 and/or C.C.	Bacterial Pneumonia (504)	1	88.1%	82.9%
			2	0.6	0.9
			3	0.4	0.8
			4	11.0	15.5
Coronary Artery Disease Cluster					
132	Atherosclerosis Age >69 and/or C.C.	Atherosclerosis of Coronary Arteries (815)	1	87.0%	81.7%
			2	7.3	12.3
			3	0.2	0.1
			4	5.5	5.8
140	Angina Pectoris	Atherosclerosis of Coronary Arteries (815)	1	60.3%	63.6%
			2	20.9	30.9
			3	18.5	4.3
			4	0.4	1.1
Prostate Disease Cluster					
336	Transurethral Prostatectomy Age >69 and/or C.C.	Benign Prostatic Hypertrophy (1008)	1	92.0%	89.9%
			2	7.0	8.7
			3	0.5	0.8
			4	0.5	0.6
346	Malignancy, Male Reproductive System, Age >69 and/or C.C.	Prostate Cancer (1001)	1	72.1%	66.3%
			2	1.0	0.6
			3	10.0	17.2
			4	17.0	15.9

^aStaging for cerebrovascular and cardiac DRGs should be interpreted carefully in light of the discussion of the limitations of staging. Many of the trends that appear to be significant are artificial; based on state specific coding practices rather than real differences in severity.

TABLE 10-8

PROCEDURE DISTRIBUTION WITHIN DRGs --- BY URBAN-RURAL LOCATION

DRG	Description	Procedure Name	Percent of Cases ^a	
			Rural	Urban
Cerebrovascular Disease Cluster				
14	Specific Cerebrovascular Disorders Except TIA	Head Cat	16.1%	38.3%
		Skull x-ray	9.6	11.8
		Spine x-ray	1.4	3.1
		Thoracic Aortography	0.9	1.8
		Cerebral Angiography	2.0	3.8
		Radionuclide Scan	13.3	14.8
		Echocardiography	2.1	5.3
		ECG	3.6	8.5
		Lumbar Puncture	3.6	4.6
15	Transient Ischemic Attacks	Head Cat	10.3	26.7
		Skull x-ray	9.5	13.3
		Spine x-ray	2.6	5.4
		Thoracic Aortography	4.8	8.1
		Cerebral Angiography	6.6	12.9
		Radionuclide Scan	13.8	19.5
		Echocardiography	2.7	5.3
		ECG	2.9	7.4
		Lumbar Puncture	1.1	1.8
Pneumonia Cluster				
79	Respiratory Infections + Inflammation Age >69 and/or C.C.	Bronchoscopy	4.8	11.1
		Chest x-rays	70.8	78.3
		Intubation ^b	2.0	3.3
		Radionuclide Scan	1.5	3.3
89	Simple Pneumonia + Pleurisy Age >69 and/or C.C.	Bronchoscopy	2.1	5.5
		Chest x-rays	67.2	75.6
		Intubation	0.8	1.6
		Radionuclide Scan	2.4	4.8
Coronary Artery Disease Cluster				
132	Atherosclerosis Age >69 and/or C.C.	Echocardiography	1.8	4.8
		Upper Gastro	7.9	9.9
		Cardiac Radionuclide Scans	1.0	6.0
		Abdomen x-rays	6.8	9.9
		Tolerance Test	1.0	1.9
		Gallbladder Study	2.8	3.5
		Holter	2.7	4.8
		Fiber Endoscopy	0.5	1.4

TABLE 10-8 (cont.)
PROCEDURE DISTRIBUTION WITHIN DRGs -- BY URBAN, RURAL^a

DRG	Description	Procedure Name	Percent of Cases	
			Rural	Urban
<u>Coronary Artery Disease Cluster</u>				
140	Angina Pectoris	Echocardiography	2.3%	5.0%
		Upper Gastro	9.4	10.3
		Cardiac Radionuclide Scans	2.0	7.5
		Abdomen x-rays	3.9	6.2
		Tolerance Test	2.7	2.3
		Gallbladder Study	3.9	4.5
		Holter	3.2	4.2
		Fiber Endoscopy	0.7	1.3
<u>Prostate Disease Cluster</u>				
336	Transurethral Prostatectomy Age >69 and/or C.C.	Cystourethroscopy	20.1	21.3
		Needle Biopsy Prostate	3.0	2.9
		X-Ray Spine, Pelvis etc.	3.5	4.8
		Abdomen X-rays	6.4	5.3
		Cystometrogram	4.3	2.9
		Ultrasound	2.3	4.9
		Urography	29.6	30.1
		Bone scan	10.1	12.2
346	Malignancy, Male Reproductive System, Age >69 and/or C.C.	Cystourethroscopy	15.5	16.5
		Needle Biopsy Prostate	7.5	7.8
		X-Ray Spine, Pelvis etc.	13.2	18.0
		Abdomen X-rays	11.3	10.6
		Cystometrogram	0.5	0.8
		Ultrasound	3.6	6.6
		Urography	14.7	14.4
		Bone scan	20.0	24.9

^aProcedures performed in less than one percent of cases were eliminated.

^bHospitals may not submit bills for intubation which is commonly performed by resident staff in teaching hospitals, therefore this figure may be an underestimate in hospitals with residents.

Source: Medicare Part A and Part B claims, 1982.

technology of head computer tomography (CAT). Despite its expense, the great clinical utility of head CAT scans should largely replace the less clinically valuable imaging techniques of skull x-rays and radionuclide brain scans. Yet, urban stroke cases are still more likely to receive these services than rural cases: 1.2 times more likely for skull x-rays and 1.1 times more likely for radionuclide brain scans. Similar results arise in the TIA cases.

Examples in which urban cases are more than twice as likely as rural cases to receive a sophisticated or specialized technology include echocardiography (DRGs 14, 132), electroencephalography (DRGs 14, 15), radionuclide cardiac scans (DRGs 132, 140), ultrasound of the abdomen and pelvis (DRGs 336, 346), and bronchoscopy (DRGs 79, 89). Somewhat surprisingly, the differentials are not quite as great for the expensive and risky technologies of cerebral angiography and thoracic aortography: urban TIA cases are 1.9 times more likely than rural cases to receive cerebral angiography and 1.8 times more likely to receive thoracic aortography.

In the great majority of cases, urban patients still receive services more often than rural cases, but the differences are smaller. For example, urban TURP (DRG 336) cases receive cystourethroscopy 26 percent more often than rural cases. Other services exhibiting this same pattern include the upper gastrointestinal series (DRGs 132, 140), gallbladder studies (DRGs 132, 133), exercise tolerance tests (DRGs 132), x-rays for bone metastases in prostate cancer (DRGs 336, 346), and chest x-rays in pneumonia (DRGs 79, 89). For patients receiving chest x-rays, urban cases invariably receive a larger number than do rural cases, implying an understatement of intensity differences in the table. Simple pneumonia patients in urban areas, for instance, receive 3.8 chest x-rays on average vs. only 2.6 in rural hospitals, nearly a 50 percent difference. Apart from cystourethroscopy, most of the services fitting this pattern are generally less costly and sophisticated.

Finally, out of the procedure lists presented in Table 10-8, there are four procedures that urban patients are less likely to receive: (1) exercise tolerance test for angina; (2) abdominal x-rays in DRGs 336 and 346; (3) cystometrogram in DRG 336, TURPs; and (4) urography in DRG 346, prostate cancer. However, in all four the differences are one percentage point or less and do not suggest any major contradiction to the strong procedure bias otherwise observed.

This bias certainly accounts for a portion of the observed cost differential between urban and rural hospital. (How much so will be analyzed statistically in Section 10.4.) Prostate disease appears a notable exception, and the much narrower ancillary cost differences (see Table 10-2) reflect it. Why do urban cases receive more services? The casemix analysis failed to identify any striking, systematic differences between urban and rural cases beyond the surgical proclivity. If this is true, and within-DRG casemix differences are minimal, then these service patterns may simply reflect practice variations driven by unequal rates of technology diffusion. That is to say, physicians in urban hospitals may recommend a battery of sophisticated (and simple) procedures in part because the technology is readily available in the institution.

10.3.2 Teaching-Nonteaching Differences

Teaching Differences in Costs and Length of Stay

Table 10-9 compares costs and lengths of stay among nonteaching, minor, and major teaching hospitals by DRG cluster. Major teaching hospitals are far more expensive than nonteaching hospitals in treating each patient cluster, even adjusting for higher area wages. For CAD patients the difference in adjusted Part A costs is 3-to-1 (\$6,232/\$2,054), followed by pneumonia at 2.3-to-1. The cost per day differences are not as large because teaching hospitals invariably have longer stays (about 10 percent) within each cluster.

CAD cases show the widest cost variation between major teaching and nonteaching hospitals: Operating room costs per admission are 16 times greater; lab and radiology and miscellaneous costs, nearly 4 times more, holding area wages constant. ICU costs are also 2.6 times greater, even though the percent admitted to an ICU is not materially higher (39 vs. 36 percent). ICU lengths of stay are 24 percent longer in major teaching hospitals once patients are admitted, however. Nevertheless, ICU costs per day in the large teaching hospitals are still nearly double those in nonteaching hospitals for CAD patients: \$612 vs. \$319. Interestingly, a similar per diem cost disparity exists for routine care: \$200 vs. \$119. It is obvious even at this stage that systematic differences in routine intensity account for a major part of the teaching cost gap.

TABLE 10-9

TEACHING COST DIFFERENCES: CARDIAC, CEREBROVASCULAR DISEASE, PNEUMONIA, AND PROSTATE DISEASE

(Number of cases)	Coronary Artery Disease			Cerebrovascular Disease			Pneumonia			Prostate Disease		
	Non-Teaching (34,450)	Minor Teaching (22,210)	Major Teaching (2,356)	Non-Teaching (29,151)	Minor Teaching (18,986)	Major Teaching (1,554)	Non-Teaching (15,876)	Minor Teaching (8,035)	Major Teaching (689)	Non-Teaching (12,240)	Minor Teaching (8,477)	Major Teaching (785)
Part A Cost	\$1,966	\$3,241	\$5,948	\$2,431	\$3,312	\$5,106	\$2,649	\$3,683	\$6,081	\$2,200	\$2,680	\$3,861
Part A (ADJ) Cost	2,054	3,431	6,232	2,569	3,508	5,443	2,724	3,776	6,205	2,406	2,905	4,111
Part A and B Cost	2,401	4,255	7,478	3,024	4,087	6,167	3,044	4,232	6,679	3,344	3,861	4,911
Part A (ADJ) Cost Per Day	253	363	611	230	272	446	240	281	457	263	281	401
Routine Costs	905	1,101	1,704	1,399	1,795	2,391	1,340	1,719	2,582	1,097	1,369	1,955
ICU Costs	338	544	864	132	172	261	116	214	414	36	31	49
OR Costs	23	206	361	37	76	211	11	22	24	321	398	502
Radiology (ADJ) Costs	129	294	498	210	331	767	162	219	464	139	186	314
Anesthesia (ADJ) Costs	12	75	254	26	46	126	5	10	12	182	214	292
Lab Costs	210	343	807	177	267	474	237	420	910	177	239	337
Miscellaneous Costs	434	863	1,737	585	820	1,266	849	1,170	1,791	444	466	655
Length of Stay (days)	8.7	9.7	9.9	12.5	14.5	13.5	11.7	13.9	13.2	9.6	10.6	10.3
Percent in ICU (%)	36.6	37.4	39.2	13.1	12.8	13.3	8.6	9.9	9.1	4.3	2.6	2.3
LOS in ICU (days)	2.9	3.6	3.6	3.1	3.0	3.6	4.3	5.8	7.3	2.6	3.1	3.4

Sources: Medicare Part A and Part B claims, 1982

Notes: Number of admissions in parentheses. Minor teaching defined as 1-24 residents per 100 beds. Major teaching includes hospitals with 25 or more residents per 100 beds.

A significant part of the major teaching cost differential is attributable to their more severe casemix, particularly for CAD and CVD patients. How important DRG and severity mix are to the observed teaching cost differential will be determined using multivariate techniques in Section 10.4. We now turn to a descriptive comparison of casemix-severity mix.

Teaching-Nonteaching Differences in Casemix-Severity

Overall, the casemix analysis presents a fairly consistent picture of major teaching institutions providing more complex services to a younger population with more serious diagnoses than non-teaching hospitals. Minor teaching hospitals fall between these two extremes.

Examining the mix of DRGs within DRGCs provides initial evidence for this pattern (see Table 10-10). In the two clusters in which the surgical option is more specialized and requires intensive service support--CAD and CVD--major teaching centers render a disproportionate amount of surgery to their cases within the cluster. For example, 20.1% of CAD cases in major teaching hospitals receive coronary artery bypass graft surgery compared to 9.6% in minor teaching hospitals and 1.1% in non-teaching hospitals. When catheterization-only cases (DRG 125) are included, over half (54.1%) of CAD cases in major teaching hospitals are surgical compared to 28% in minor teaching hospitals, and 5.1% in non-teaching hospitals. Similarly, 17.6% of major teaching hospitals cases with CVD receive extracranial surgery compared to 8.4% in minor teaching hospitals and 5.3% in non-teaching hospitals.

The relatively less complex TURP surgery, however, points in the opposite direction. Cases admitted for prostatic disease are most likely to receive a simple TURP (DRGs 336 and 337) in non-teaching hospitals (68%) compared to minor teaching hospitals (64.9%) and major teaching hospitals (56.3%).

The prostatic disease example also highlights our second major finding: complex diagnoses comprise a disproportionate fraction of major teaching hospital caseloads. The percentage of cases admitted for medical treatment of prostate cancer (DRGs 346 and 347) is 24.4% in major teaching hospitals, compared to 13.9% in minor teaching hospitals and 14.5% in non-teaching hospitals. The ratio of medical admissions for cancer compared to benign prostatic hypertrophy (DRGs 346 and 347/DRGs 348 and 349) is 3.5 in major

TABLE 10-10

DRG MIX BY TEACHING STATUS

	<u>No Teaching</u>	<u>Minor Teaching</u>	<u>Major Teaching</u>
<u>CORONARY ARTERY DISEASE</u>	(n=33,840)	(n=21,692)	(n=2,369)
106 Coro bypass w/Cardiac Cath.	0.6%	4.4%	11.1%
107 Coro bypass w/o Cardiac Cath.	0.5	5.2	9.0
125 Circ dis w C.C. w/o comp.	4.0	18.4	34.0
132 Athero > 69 and/or C.C.	30.4	20.8	10.5
133 Athero < w/o C.C.	8.6	5.2	6.5
140 Angina Pectoris	44.3	37.7	20.8
143 Chest Pain	11.6	8.4	8.0
<u>CERBROVASCULAR DISEASE</u>	(n=29,151)	(n=18,986)	(n=1,554)
5 Excranial Vasc Proc	5.3%	8.4%	17.6%
14 Spec Cerebro Dis exc. TIA	53.8	52.6	49.6
15 TIA	31.3	31.0	25.6
16 NonSpec Cerbro Dis w C.C.	1.3	1.6	0.8
17 NonSpec Cerbro Dis w/o C.C.	8.3	6.4	6.4
<u>PNEUMONIA</u>	(n=15,876)	(n=8,035)	(n=684)
79 Resp Infect+Infl >69 +/or C.C.	6.3%	8.4%	15.6%
80 Resp Infect+Infl 18-69 w/o C.C.	1.2	1.6	4.1
81 Resp Infect+Infl 0-17	0.2	0.2	0.0
89 Simp Pneu+Pleur >69 +/or C.C.	75.0	73.2	62.4
90 Simp Pneu+Pleur 18-69	15.7	13.6	17.5
91 Simp Pneu+Pleur 0-17	1.6	2.9	0.3
<u>PROSTATE DISEASE</u>	(n=12,240)	(n=8,477)	(n=785)
306 Prost >69+/or C.C.	7.0%	10.0%	9.7%
307 Prost < 70 w/o C.C.	2.0	3.3	2.8
336 TURP >69+/or C.C.	51.3	49.3	42.9
337 TURP < 70 w/o C.C.	16.7	15.6	13.4
346 Cancer Repro. >69+/or C.C.	12.7	11.7	18.9
347 Cancer Repro < 70 w/o C.C.	1.8	2.2	5.5
348 Benign Prost Hyper >69+/or C.C.	6.5	6.0	5.4
349 Benign Prost Hyper < 70 w/o C.C.	2.1	2.0	1.5

Sources: Medicare Part A and Part B claims, 1982

Note: Minor teaching = less than 25 residents per 100 beds.

Major teaching = more than 25 residents per 100 beds.

teaching hospitals, but only 1.7 in minor and non-teaching hospitals. Pneumonia yields a similar finding: 19.7% of major teaching hospital cases fall into the more serious DRGs 79, 80, and 81, compared to 10.2% in minor teaching hospitals, and 7.7% in non-teaching hospitals. In CVD, the ratio of stroke to TIA cases is slightly higher in major teaching hospitals compared to minor teaching hospitals and non-teaching hospitals.

Comparing DRG pairs split on the basis of age 70 and comorbidity also yields a uniform, but contrary, trend.* The ratio of older, complicated cases to younger, uncomplicated cases is generally lowest in major teaching hospitals. For example, in prostate cancer, the ratio of cases in DRG 346 to cases in DRG 347 is 3.4 in major teaching hospitals, 5.3 in minor teaching hospitals, and 7.1 in non-teaching hospitals; in atherosclerosis, the ratio of cases in DRG 132 to cases in DRG 133 is 1.6 in major teaching hospitals, 4.0 in minor teaching hospitals, and 3.5 in non-teaching hospitals. These findings suggest that major teaching hospitals treat a "younger" group of Medicare patients than do the other two types. This is consistent with expectations: major teaching hospitals are more likely to attract younger persons who desire a more aggressive, rigorous therapeutic approach or diagnostic evaluation.

Further age breakdowns confirm these findings (see Table 10-11). In the eight DRGs which form the particular focus of this descriptive analysis, major teaching hospitals have the lowest fraction of "old old" in seven cases. The sole exception is DRG 336, TURP, where they actually have the highest percentage of the frail elderly. A probable explanation for this finding is that some very old patients who need TURPs are significant surgical risks who actively seek the specialized support of major teaching hospitals.

Looking at proportions of cases dying in these same eight DRGs (see the same Table 10-11), the trends are not as consistent, but the findings do make some clinical sense. In pneumonia (DRGs 79 and 89) and CAD (DRGs 132 and 140), major teaching hospitals have the highest death rates; non-teaching hospitals have the lowest death rates in all but DRG 132. Cases in these DRGs are probably acutely ill, with higher death rates

*In interpreting these findings, it is important to remember that the vast majority of cases are placed in the more complicated DRG on the basis of old age; less than one quarter of these cases have a qualifying comorbidity listed.

TABLE 10-11

PERCENT FRAIL ELDERLY AND EXPIRED BY TEACHING STATUS

DRG	Description	Percent Above Age Cut-off ^a			Percent Died		
		Non-Teaching	Minor-Teaching	Major Teaching	Non-Teaching	Minor-Teaching	Major Teaching
Cerebrovascular Disease Cluster							
14	Specific Cerebrovascular Disorders Except TIA	15.9%	15.9%	10.0%	18.1%	18.0%	15.2%
15	Transient Ischemic Attacks	16.6	13.8	6.6	1.3	1.5	1.0
Pneumonia Cluster							
79	Respiratory Infections + Inflammation Age >69 and/or C.C.	39.4	37.5	34.6	18.1	22.2	24.3
89	Simple Pneumonia + Pleurisy Age >69 and/or C.C.	41.2	44.9	36.8	11.8	15.0	16.6
Coronary Artery Disease Cluster							
132	Atherosclerosis Age >69 and/or C.C.	18.5	17.1	10.5	6.6	5.8	8.1
140	Angina Pectoris	7.1	6.8	5.9	0.9	1.3	2.7
Prostate Disease Cluster							
336	Transurethral Prostatectomy Age >69 and/or C.C.	26.5	25.8	28.5	0.5	1.2	1.5
346	Malignancy, Male Reproductive System, Age >69 and/or C.C.	27.1	29.9	21.6	18.4	16.6	4.1

^aAge cut-off = 80 for DRGs 79, 89, 336, 346.

85 for DRGs 14, 15, 132, 140.

Source: Medicare Part A and Part B claims, 1982.

indicating that major teaching hospital cases are more severely ill than those at the other two institutional types. By contrast, in DRGs 14, stroke, and 346, prostate cancer, major teaching hospitals have the lowest death rates. These two DRGs involve protracted, chronic illnesses. These patients may be more likely to receive prolonged, terminal care outside of the acute, intensive setting of a major teaching hospital. Death rates in the remaining two DRGs are too low to make meaningful comparisons.

Disease mix and stages for selected DRGs are presented in Table 10-12. Comparisons again are limited because of problems with the staging algorithm and variability in disease coding across states. The major results appear in respiratory infections (DRG 79): more major teaching hospital cases have tuberculosis (24.3%), compared to 16.0% at minor teaching hospitals, and 12.3% at non-teaching hospitals. Surprisingly, more non-teaching hospital TURP (DRG 336) cases have cancer (23.9%) than major teaching hospital cases (19.9%). Finally, the disease groupings for stroke (DRG 14) are different across hospital types, with major teaching hospitals most likely to have cases staged as aneurysm, atrial fibrillation, and essential hypertension. Because diseases are not directly comparable on a severity continuum, and because of coding variability it is difficult to interpret the clinical meaning of these findings.

The stages themselves (as opposed to the disease categories in Table 10-12) provide the one major inconsistency to this casemix analysis (see Table 10-13). In many cases, major teaching hospitals have a higher proportion of lower-staged cases than do the other hospital types. For example, in TURP (DRG 336) patients with the simple diagnosis of BPH, 94.2% of major teaching hospital cases are stage 1 compared to 90.7% in non-teaching hospitals. In angina (DRG 140), 9.4% of non-teaching hospital cases are Stage 3 compared to 3.3% in major teaching hospitals. Because of the small numbers and the potential of state-specific coding artifacts, the role of these staging results in the overall picture of teaching hospitals is unclear. Based on these data alone, one cannot derive any definitive conclusions about severity differences among these hospital types.

Nevertheless, with the exception of the staging results, a fairly uniform portrait emerges of casemix in various teaching settings. A probable scenario arises of relatively younger patients receiving a more sophisticated set of surgical services in major teaching hospitals. Less

TABLE 10-12

COMMON STAGING DISEASE ASSIGNMENTS WITHIN DRGS BY TEACHING STATUS

DRG	Description	Disease Name and Number	Percent of Cases		
			Non-Teaching	Minor-Teaching	Major Teaching
<u>Cerebrovascular Disease Cluster</u>					
14	Specific Cerebrovascular Disorders Except TIA	Disease of Carotid Artery (251) Aneurysm of Cerebral Vessels (253) Disease of Vertebral Artery (254) Atrial Fibrillation (817) Essential Hypertension (829)	0.6% 4.9 86.8 1.2 5.6	0.8% 6.2 84.9 0.8 6.3	0.4% 7.8 79.1 2.1 9.0
15	Transient Ischemic Attacks	Disease of Carotid Artery (251) Disease of Basilar Artery (252) Disease of Vertebral Artery (254)	81.6 15.2 3.0	86.1 9.3 4.3	83.6 9.3 7.1
<u>Pneumonia Cluster</u>					
79	Respiratory Infections + Inflammation Age >69 and/or C.C.	Anaerobic Infections (411) Bacterial Pneumonia (504) Tuberculosis (514) Other Respiratory Conditions (590)	10.2 33.5 12.3 30.1	10.6 26.0 16.0 30.0	11.2 15.9 24.3 29.9
89	Simple Pneumonia + Pleurisy Age >69 and/or C.C.	Bacterial Pneumonia (504) Other Respiratory Conditions (590)	90.1 2.2	91.4 1.2	91.3 1.9
<u>Coronary Artery Disease Cluster</u>					
132	Atherosclerosis Age >69 and/or C.C.	Acute Myocardial Infarction (811) Atherosclerosis of Coronary Arteries (815)	0.1 93.7	0.2 92.8	0.0 84.6
140	Angina Pectoris	Acute Myocardial Infarction (811) Atherosclerosis of Coronary Arteries (815)	0.0 99.6	0.1 99.3	0.0 99.8
<u>Prostate Disease Cluster</u>					
336	Transurethral Prostatectomy Age >69 and/or C.C.	Prostate Cancer (1001) Benign Prostatic Hypertrophy (1008)	23.9 73.3	23.8 73.0	19.9 77.2
346	Malignancy, Male Reproductive System, Age >69 and/or C.C.	Prostate Cancer (1001)	96.0	95.4	99.3

Source: Medicare Part A and Part B claims, 1982.

10-13

STAGING ASSIGNMENTS WITH THE MOST COMMON STAGED DISEASE CATEGORY BY TEACHING STATUS

DRG	Description	Disease Name and Number	Stage	Percent of Cases ^a		
				Non-Teaching	Minor-Teaching	Major-Teaching
<u>Cerebrovascular Disease Cluster</u>						
14	Specific Cerebrovascular Disorders Except TIA	Disease of Vertebral Artery (254)	1	0.0%	0.0%	0.0%
			2	81.5	81.9	84.9
			3	0.2	0.1	0.3
			4	18.4	18.0	14.8
15	Transient Ischemic Attacks	Disease of Carotid Artery (251)	1	96.3%	96.1%	96.4%
			2	2.5	2.5	2.7
			3	0.0	0.0	0.0
			4	1.2	1.4	0.9
<u>Pneumonia Cluster</u>						
79	Respiratory Infections + Inflammation Age >69 and/or C.C.	Bacterial Pneumonia (504)	1	77.3%	71.6%	76.5%
			2	3.0	4.0	0.0
			3	2.7	1.1	0.0
			4	17.1	23.3	23.5
89	Simple Pneumonia + Pleurisy Age >69 and/or C.C.	Bacterial Pneumonia (504)	1	85.9%	81.9%	79.5%
			2	0.7	0.9	1.0
			3	0.6	0.9	1.3
			4	12.9	16.3	18.2
<u>Coronary Artery Disease Cluster</u>						
132	Atherosclerosis Age >69 and/or C.C.	Atherosclerosis of Coronary Arteries (815)	1	85.2%	80.5%	83.3%
			2	8.6	14.6	10.1
			3	0.2	0.1	0.0
			4	6.1	4.8	6.7
140	Angina Pectoris	Atherosclerosis of Coronary Arteries (815)	1	64.6%	60.0%	60.6%
			2	25.3	35.0	33.5
			3	9.4	3.8	3.3
			4	0.8	1.2	2.7
<u>Prostate Disease Cluster</u>						
336	Transurethral Prostatectomy Age >69 and/or C.C.	Benign Prostatic Hypertrophy (1008)	1	90.7%	89.5%	94.2%
			2	8.3	9.0	3.5
			3	0.7	0.7	1.2
			4	0.4	0.8	1.2
346	Malignancy, Male Reproductive System, Age >69 and/or C.C.	Prostate Cancer (1001)	1	68.1%	65.4%	77.6%
			2	0.7	0.5	1.4
			3	13.4	18.6	17.0
			4	17.8	15.5	4.1

^aStaging for cerebrovascular and cardiac DRGs should be interpreted carefully in light of the limitations of staging. Many of the trends that appear to be significant are artificial, based on state-specific coding practices rather than real differences in severity.

complex surgery is performed in non-teaching hospitals, but if patients are very old, even simple surgery is rendered more in major teaching hospitals (these patients may represent greater surgical risks). Cases treated medically have more complex diagnoses in major teaching hospitals. Acutely ill patients are more likely to die in major teaching hospitals, probably indicating greater disease severity. But patients with chronic diseases have higher death rates in non-teaching hospitals, suggesting perhaps that prolonged terminal care is more likely in the less intensive non-teaching setting.

Teaching Differences in Within-DRG Procedure Mix

Examining procedure mix within the eight DRGs yield generally consistent findings: cases in major teaching hospitals received far more services overall and services of greater technologic sophistication than cases in non-teaching hospitals. For highly sophisticated services (e.g., cerebral angiography), the minor teaching hospital experience was more similar to that of non-teaching hospitals than that of major teaching hospitals. However, for less sophisticated services, the experience of major and minor teaching hospitals was comparable.

The most interesting differences appear in the CVD cluster, particularly stroke (DRG 14) and TIAs (DRG 15). Non-teaching hospitals appear to use established technologies (skull x-rays, radionuclide brain scans) in place of the newer but expensive head computer tomography, or CAT scan. For example, nearly two-thirds of stroke cases at major teaching hospitals received head CT, compared to 43% at minor teaching hospitals and one quarter at non-teaching hospitals (see Table 10-14).

TIA (DRG 15) offered identical findings. For the most sophisticated technologies on the list (cerebral angiography and thoracic aortography), major teaching hospitals are dramatically different from both minor and non-teaching hospitals. At major teaching hospitals, 4 out of 10 TIA cases received cerebral angiography compared to 1-in-6 at minor teaching hospitals and 1-in-15 at non-teaching hospitals. And at major teaching hospitals, 1-in-3 of TIA cases receive thoracic aortography, compared to 1-in-10 at minor teaching hospitals and 1-in-20 at non-teaching hospitals. Similarly, for echocardiography and electroencephalography (EEG), experience at major teaching hospitals is also strikingly more intensive than that found in minor and non-teaching hospitals. At major teaching hospitals, roughly

TABLE 10-14

PROCEDURE DISTRIBUTION WITHIN DRGS BY TEACHING STATUS

DRG	Description	Procedure Name ^a	Percent of Cases		
			Non Teaching	Minor Teaching	Major Teaching
<u>Cerebrovascular Disease Cluster</u>					
14	Specific Cerebrovascular Disorders Except TIA	Head Cat	25.3%	43.4%	63.9%
		Skull x-ray	12.1	10.4	5.1
		Spine x-ray	2.3	3.3	5.1
		Thoracic Aortography	0.9	2.0	9.1
		Cerebro Angiography	2.1	4.7	11.3
		Radionuclide Scan	16.0	12.9	3.5
		Echocardiography	3.2	5.3	22.7
		EEG	6.4	7.5	25.0
		Lumbar Puncture	4.3	4.1	10.8
<u>15 Transient Ischemic Attacks</u>					
		Head Cat	16.2	33.1	48.6
		Skull x-ray	13.4	11.7	4.5
		Spine x-ray	4.3	5.7	5.0
		Thoracic Aortography	4.8	9.9	33.5
		Cerebro Angiography	7.1	16.7	41.6
		Radionuclide Scan	19.6	17.4	5.3
		Echocardiography	3.2	5.6	27.7
		EEG	5.5	7.1	23.4
		Lumbar Puncture	1.2	2.0	6.6
<u>Pneumonia Cluster</u>					
79	Respiratory Infections + Inflammation Age >69 and/or C.C.	Bronchoscopy	7.9	11.5	10.3
		Chest X-rays	73.7	79.2	83.2
		Intubation ^b	3.1	2.7	2.8
		Radionuclide Scan	2.9	2.7	2.8
<u>89 Simple Pneumonia + Pleurisy Age >69 and/or C.C.</u>					
		Bronchoscopy	3.5	6.2	5.9
		Chest X-rays	70.8	76.9	86.0
		Intubation	1.1	1.8	1.9
		Radionuclide Scan	4.0	4.2	4.5
<u>Coronary Artery Disease Cluster</u>					
132	Atherosclerosis Age >69 and/or C.C.	Echocardiography	2.7	5.4	13.8
		Upper Gastro	8.8	10.0	8.9
		Cardiac Radionuclide Scans	2.6	7.7	18.6
		Abdomen x-rays	7.7	10.9	15.0
		Tolerance Test	1.0	0.8	10.5
		Venous Catheter	0.6	0.4	1.6
		Gallbladder Study	3.2	3.4	1.2
		Holter	2.9	5.9	15.8
		Fiber Endoscopy	0.9	1.5	0.8

TABLE 10.14(cont.)

PROCEDURE DISTRIBUTION WITHIN DRGS BY TEACHING STATUS

DRG	Description	Procedure Name ^a	Percent of Cases		
			Mon Teaching	Minor Teaching	Major Teaching
140	Angina Pectoris	Echocardiography	3.4%	5.9%	9.6%
		Upper Gastro	9.9	10.7	8.2
		Cardiac Radionuclide Scans	3.8	10.7	12.2
		Abdomen x-rays	5.1	6.8	8.4
		Tolerance Test	2.0	2.7	11.4
		Venous Catheter	0.1	0.2	1.6
		Gallbladder Study	4.6	4.2	1.6
		Holter	2.8	5.7	12.2
		Fiber Endoscopy	1.0	1.5	1.2
Prolactin Disease Cluster					
336	Transurethral Prostatectomy Age >69 and/or C.C.	Cystourethroscopy	19.4%	23.8%	18.1%
		Needle Biopsy Prostate	2.6	3.2	4.5
		X-Ray Spine, Pelvis etc.	3.8	5.6	4.5
		Abdomen X-rays	5.4	5.8	5.6
		Cystometrogram	2.8	3.2	9.5
		Ultrasound	3.7	5.2	8.0
		Urography	30.2	30.0	24.3
		Bone scan	10.5	13.8	11.0
346	Malignancy, Male Reproductive System, Age >69 and/or C.C.	Cystourethroscopy	15.7%	17.6%	12.2%
		Needle Biopsy Prostate	6.9	9.0	7.4
		X-Ray Spine, Pelvis etc.	13.5	21.2	21.6
		Abdomen X-rays	9.6	13.4	6.1
		Cystometrogram	0.5	0.9	2.0
		Ultrasound	4.7	7.7	6.1
		Urography	14.0	15.2	14.2
		Bone scan	21.4	26.1	32.4

^aProcedures performed in less than one percent of cases were eliminated.^bHospitals may not submit bills for intubation which is commonly performed by resident staff in teaching hospitals, therefore this figure may be an underestimate in hospitals with residents.

Source: Medicare Part A and Part B claims, 1982.

1-in-5 stroke cases received echocardiography, compared to 1-in-20 at minor teaching hospitals and 3-in-100 at non-teaching hospitals. Also, at major teaching hospitals, 1-in-4 stroke cases received EEGs, compared to 7-in-100 minor teaching hospitals and 6-in-100 at non-teaching hospitals. These two services require specialists (cardiologists for echocardiography and neurologists for EEGs), but the techniques are non-invasive, with virtually no patient risk, and the capital investment in equipment is far less than for a service such as arteriography. Considered in this light, the wide difference between major and minor teaching hospitals is somewhat surprising, and probably reflects a true differences in the style of diagnostic work-up and not inpatient severity.

The findings in the CAD example--coronary atherosclerosis (DRG 132) and angina (DRG 140)--are less dramatic, but consistent with the CVD results. Major teaching hospitals provide a more intensive set of services when compared to minor and non-teaching hospitals. Echocardiography, radionuclide cardiac scans, exercise tolerance tests, and Holter monitors are all performed most often in major teaching hospitals and least often in non-teaching hospitals, with minor teaching hospitals again closer to the non-teaching hospitals' experience. For example, roughly 1-in-5 coronary atherosclerosis cases in major teaching hospitals receive a radionuclide cardiac scan compared to 8-in-100 in minor teaching hospitals and 3-in-100 in non-teaching hospitals. However, minor teaching hospitals and non-teaching hospitals pursue gastrointestinal work-ups more than do major teaching hospitals. More upper gastrointestinal series, gallbladder studies, and even fiberoptic gastrointestinal endoscopies are performed in minor teaching hospitals and non-teaching hospitals than in major teaching hospitals. For example, 4.6% of non-teaching hospital angina cases had their gallbladders studied compared to 4.2% in minor teaching hospitals and 1.6% in major hospitals. Gastrointestinal pain can sometimes mimic cardiac pain, so these evaluations are probably clinically appropriate. But this differential use of these tests in the diagnosis of cardiac disease likely reflects a difference in practice styles since these cases were classified as either angina or coronary atherosclerosis based on discharge diagnostic data. One possibility is that teaching hospital cases could be receiving their gastrointestinal work-ups as outpatients or during subsequent admissions.

The prostate cluster examples--TURP (DRG 336) and prostate cancer (346)--contain fewer technologic options but also display an exception to the trends described above. The most expensive, specialized, and risky technology, cystourethroscopy is provided least frequently in major teaching hospitals and most frequently in minor teaching hospitals. The same is true for urography. What accounts for these contradictory results?

Cystourethroscopy and urography are important parts of the preoperative evaluation but can be performed on an ambulatory basis. Thus, several potential explanations arise: (1) major teaching hospital cases can have the procedures performed during prior nonsurgical admissions; or (2) they have the procedures as outpatients; or (3) their TURP cases are largely referrals and have had much of their work-up elsewhere.

In terms of the other technologies, non-teaching hospitals generally provide fewer services while the major and minor teaching hospitals compete for the distinction of offering the most. For example, 9.0% of minor teaching hospital prostate cancer cases receive needle biopsies compared to 7.4% at major teaching hospitals and 6.9% at non-teaching hospitals; 9.5% of major teaching hospital TURP cases receive cystometograms compared to 3.2% at minor teaching hospitals and 2.8% at non-teaching hospitals.

Pneumonia has the fewest technologic options of the four clusters, but the findings for the major procedure, bronchoscopy, are similar for major and minor teaching hospitals. In the general pneumonia group (DRG 89), 6.2% of minor teaching hospital and 5.9% of major teaching hospital cases receive bronchoscopy compared to 3.5% of non-teaching hospitals cases. Major and minor teaching hospital cases are also more likely to receive x-rays and radionuclide pulmonary scans. They also receive many more chest x-rays per admission: 4.8 in major teaching hospitals vs. 2.8 in non-teaching hospitals.

Allowing for a few inconsistencies, the data generally support the a priori intuition that cases in major teaching hospitals receive a more numerous and complex mix of services, followed by minor and then non-teaching hospitals. This finding, weighed with the casemix data showing major teaching hospitals treating a younger population with more serious, acute diagnoses, suggests a scenario of relatively younger, perhaps "sicker", patients receiving aggressive, technology-intensive evaluations and therapies in major teaching hospitals. This could account for at least a portion of the observed cost differential.

10.3.3 Bedsize Comparisons

Bedsizes Differences in Costs and Lengths of Stay

Cost differences are not so pronounced between large and small hospitals generally as they are between teaching and nonteaching institutions (see Table 10-15). Among cardiac patients, for example, the 3-to-1 major teaching-nonteaching cost difference is "only" 1.9-to-1 for over-400 vs. less-than-100 bed hospitals (\$3,610/\$1,865). In fact, bedsize has practically no effect on adjusted admission costs among prostate patients (only 6 percent higher in large hospitals).

Lengths of stay differences are comparatively greater, however, by bedsize than by teaching status. Whereas LOS differences for major teaching vs. nonteaching hospitals ranged from 6 (prostate) to 13 percent (CAD), a 24 (prostate) to 56 percent (cerebrovascular) range is found across large vs. small bedsizes.

Putting the narrower bedsize cost differences together with their wider LOS differences implies that the intensity effect is far greater in major teaching institutions than in large hospitals generally. Again, CAD patients are the most extreme example. Subtracting routine and ICU accommodation costs from total Part A adjusted costs gives a residual estimate of ancillary costs per admission. For major teaching hospitals, the figure is \$3,655 vs. only \$818 in nonteaching hospitals, a 4.5-to-1 difference. The gap is only 2.5-to-1 (\$1,892 vs. \$752) in over-400 bed vs. less-than-100 bed hospitals. Even among pneumonia patients, than ancillary gap is 2.5-to-1 by major vs. nonteaching status compared to a 1.5-to-1 gap by large vs. small bedsize.

Bedsizes Differences in Casemix-Severity

The casemix analysis detected consistent differences related to hospital bedsize. First, within each DRGC, cases treated in small hospitals were always least likely to receive surgery. Second, cases in small hospitals were consistently older than cases in large and medium-sized hospitals. Third, despite this age differential, cases in small hospitals were least likely to die (with one exception, see discussion below).

TABLE 10-15

BEDSIZE COST DIFFERENCES: CORONARY ARTERY DISEASE, CEREBROVASCULAR DISEASE, PNEUMONIA, AND PROSTATE DISEASE

(Number of cases)	Coronary Artery Disease			Cerebrovascular Disease			Pneumonia			Prostate Disease		
	Small Bedsize (7,326)	Medium Bedsize (29,430)	Large Bedsize (21,760)	Small Bedsize (5,375)	Medium Bedsize (26,626)	Large Bedsize (17,690)	Small Bedsize (4,432)	Medium Bedsize (12,830)	Large Bedsize (7,333)	Small Bedsize (1,718)	Medium Bedsize (12,028)	Large Bedsize (7,756)
	\$1,786	\$2,212	\$3,420	\$2,087	\$2,648	\$3,391	\$2,554	\$2,929	\$3,670	\$2,543	\$2,270	\$2,708
Part A Cost	1,865	2,320	3,610	2,170	2,803	3,599	2,629	3,008	3,762	2,761	2,480	2,930
Part A (ADJ) Cost	2,082	2,778	4,431	2,441	3,317	4,177	2,866	3,386	4,195	3,590	3,451	3,846
Part A and B Cost	269	273	370	232	240	278	260	246	282	326	263	283
Part A (ADJ) Cost Per Day												
Routine Costs	915	919	1,169	1,308	1,487	1,807	1,353	1,424	1,716	1,250	1,149	1,367
ICU Costs	198	413	549	67	158	166	60	164	201	25	37	32
OR Costs	4	55	210	11	48	85	4	15	22	324	332	405
Radiology (ADJ) Costs	119	155	305	138	235	374	157	178	226	147	147	195
Anesthesia (ADJ) Costs	4	27	84	8	32	52	2	7	10	209	186	214
Lab Costs	212	219	399	161	193	281	208	276	448	201	181	249
Miscellaneous Costs	406	529	893	469	647	839	835	941	1,137	574	441	465
Length of Stay (days)	7.4	9.0	9.9	10.2	13.0	14.6	10.4	12.4	13.8	8.6	9.9	10.7
Percent in ICU (%)	27.2	40.2	35.9	8.0	14.4	12.5	5.2	10.0	9.6	3.1	4.4	2.4
LOS in ICU (days)	2.4	2.9	3.8	2.6	3.2	3.6	4.0	4.7	5.5	2.4	2.6	3.2

Sources: Medicare Part A and Part B claims, 1982

Note: Number of admissions in parentheses. Small bedsize defined as less than 100 beds; Medium bedsize = 100-400 beds; Large bedsize = over 400 beds.

All dollar figures have been deflated by the area wage index.

The issue of surgery is most apparent in the two clusters containing rather complex surgery--CAD and CVD (see Table 10-16). The percent of cases within the CAD DRGC receiving coronary artery surgery (DRGs 106 and 107) is only 3-in-1000 in small hospitals compared to 1-in-36 in medium hospitals and 1-in-10 in large hospitals. In the CVD cluster, the percent of cases receiving surgery (DRG 5), is 1.6% in small hospitals, 6.3% in medium hospitals, and 9.4% in large hospitals.

Examining patterns of medical admissions fails to document any striking differences in diagnostic complexity across the three hospital bedsizes. Cases in large hospitals are somewhat more likely (9.7%) to fall into the more complex pneumonia DRGs (79, 80, 81) compared to medium hospitals (8.9%) and small hospitals (7.3%). Similarly, CVD cases in large hospitals are slightly more likely to have had strokes (DRG 14) than TIAs (DRG 15) when compared to medium and small hospitals. However, the ratio of medical prostate cancer cases (DRGs 346 and 347) to medical benign hypertrophy cases (DRGs 348 and 349) is roughly equal across the three bedsizes, even though a disproportionate share of prostatic disease patients undergo medical treatment for cancer at small hospitals (20.1%, compared to 14.9% at large hospitals and 13.6% at medium hospitals).

Comparing DRG pairs split by age 70 and comorbidities, a definite trend does arise: small hospitals uniformly have a larger share of cases in the older, complicated grouping than do medium and large hospitals. For example, the ratio of older, complicated prostate cancer cases (DRG 346) to younger, uncomplicated prostate cancer cases (DRG 347) is 9.1 in small hospitals, 6.6 in medium hospitals, and "only" 5.2 in large hospitals.

This is primarily an age effect (see Table 10-17). For example, 23.3% of small hospital TIA cases (DRG 15) are over age 85, compared to 15.2% at medium hospitals and 12.7% at large hospitals; 34.4% of small hospital medical prostate cancer cases (DRG 346) are over age 80 compared to 27.8% at medium hospitals and 25.8% at large hospitals.

Despite the fact that small hospitals care for a relatively very old population, their patients do not die as frequently as those in medium and large hospitals (at least prior to discharge). In seven of the eight DRGs, small hospitals had the lowest death rates (see Table 10-17).

The disease assignment distributions provide only limited information (see Table 10-18). Of greatest note is the similar proportion of TURP cases (DRG 336) with prostate cancer across the three bedsize groups. Also interesting is the fact that tuberculosis cases are more common in large

TABLE 10-16

DRG MIX BY HOSPITAL SIZE

	<u>Small Hospital</u>	<u>Medium Hospital</u>	<u>Large Hospital</u>
CORONARY ARTERY DISEASE	(n=7,120)	(n=29,191)	(n=21,590)
106 Coro bypass w/cath.	0.1%	1.6%	4.4%
107 Coro bypass w/o cath.	0.2	1.2	5.4
125 Circ dis w C.C. w/o comp.	0.6	6.7	19.5
132 Athero > 69 and/or C.C.	36.2	27.0	21.3
133 Athero < w/o C.C.	7.9	7.7	6.4
140 Angina Pectoris	42.4	44.7	35.1
143 Chest Pain	12.8	11.2	8.1
CEREBROVASCULAR DISEASE	(n= 5,375)	(n=26,626)	(n=17,690)
5 Exocranial Vasc Proc	1.6%	6.3%	9.4%
14 Spec Cerebro Dis exc. TIA	55.7	52.6	53.3
15 TIA	32.7	32.0	29.0
16 NonSpec Cerbro Dis w C.C.	1.5	1.5	1.3
17 NonSpec Cerbro Dis w/o C.C.	8.5	7.6	7.1
PNEUMONIA	(n= 4,432)	(n=12,830)	(n=7,333)
79 Resp Infect+Infl >69 +/or C.C.	6.3%	7.2%	7.8%
80 Resp Infect+Infl 18-69 w/o C.C.	1.0	1.5	1.6
81 Resp Infect+Infl 0-17	0.0	0.2	0.3
89 Simp Pneu+Pleur >69 +/or C.C.	77.6	74.3	71.5
90 Simp Pneu+Pleur 18-69	14.7	14.9	15.6
91 Simp Pneu+Pleur 0-17	0.3	1.9	3.1
PROSTATE DISEASE	(n= 1,718)	(n=12,028)	(n=7,756)
306 Prost >69+/or C.C.	10.7%	7.5%	8.9%
307 Prost < 70 w/o C.C.	2.9	2.2	2.9
336 TURP >69+/or C.C.	44.5	51.7	49.1
337 TURP < 70 w/o C.C.	11.4	16.9	16.2
346 Cancer Repro. >69+/or C.C.	18.1	11.8	12.5
347 Cancer Repro < 70 w/o C.C.	2.0	1.8	2.4
348 Benign Pros Hyper >69+/or C.C.	8.6	6.1	5.9
349 Benign Prost Hyper < 70 w/o C.C.	2.0	1.9	2.2

Sources: Medicare Part A and Part B claims, 1982

TABLE 10-17

PERCENT FRAIL ELDERLY AND EXPIRED BY HOSPITAL SIZE

DRG	Description	Percent Above Age Cut-off ^a			Percent Died		
		Small Hospital	Medium Hospital	Large Hospital	Small Hospital	Medium Hospital	Large Hospital
<u>Cerebrovascular Disease Cluster</u>							
14	Specific Cerebrovascular Disorders Except TIA	20.1%	16.4%	13.3%	16.1%	18.9%	17.2%
15	Transient Ischemic Attacks	23.3	15.2	12.7	0.7	1.5	1.4
<u>Pneumonia Cluster</u>							
79	Respiratory Infections + Inflammation Age >69 and/or C.C.	46.6	38.3	34.6	15.1	21.6	19.9
89	Simple Pneumonia + Pleurisy Age >69 and/or C.C.	43.2	42.5	41.3	8.3	13.4	15.0
<u>Coronary Artery Disease Cluster</u>							
132	Atherosclerosis Age >69 and/or C.C.	22.9	17.3	16.1	5.7	6.4	6.8
140	Angina Pectoris	8.5	7.1	6.2	0.3	1.1	1.4
<u>Prostate Disease Cluster</u>							
336	Transurethral Prostatectomy Age >69 and/or C.C.	28.3	26.7	25.2	0.4	0.9	0.8
346	Malignancy, Male Reproductive System, Age >69 and/or C.C.	34.4	27.8	25.8	17.7	17.9	15.2

Source: Medicare Part A and Part B claims, 1982.

Note: Disease numbers based on Systemetrics staging algorithm.

^aAge cut-off = 80 for DRGs 79, 89, 336, 346.
85 for DRGs 14, 15, 132, 140.

hospitals (18.2% of the DRG 79 cases) compared to medium hospitals (13.7%) and small hospitals (9.0%). This may be related to whether some hospitals routinely admit patients for evaluation of tuberculosis. However, the fraction dying (Stage 4) is lowest in large hospitals (5.9%) and highest in small hospitals (12.0%).

Overall, Stage 4 patterns follow from what has already been described: small hospitals generally have the lowest death rates. Results across lower disease stages fail to follow any trend (see Table 10-19). In some cases, small hospitals have more Stage 3 cases; in others, medium hospitals or large hospitals have more Stage 3 cases. Thus, while the Stage 4 results provide confirmation of some portions of the casemix analysis, the other staging results do not add any clear evidence on disease severity.

These casemix findings in some sense confirm prior expectations regarding bedsize and severity; yet in another sense raise an interesting puzzle. The surgery results were clearly anticipated: most small hospitals are probably not equipped to perform complex procedures such as open heart surgery, and the data show that they do not. The interesting contradiction is the consistent finding that cases in small hospitals are systematically older but they die less frequently in the hospital. As a general rule, older people are at greater risk simply due to the multiple processes known generically as the "ravages of age." Why aren't the death rates at small hospitals higher given the preponderance of these very old cases? One explanation involves the purpose of admission and disease severity at the time of hospitalization. The very old may seek care at their local, small hospital if they are sufficiently ill to be hospitalized but not sick enough to require the extensive specialized support services which are perhaps more available at large hospitals. "Younger" persons who desire aggressive use of such services or who are severely ill may differentially select large urban hospitals, or are triaged there by local physicians. These combined biases could produce such results. Alternatively, small hospitals tend to be disproportionately found in rural areas where the population is older. Their patients, therefore, will naturally be older. At the end, they may prefer to be discharged and die elsewhere (at home?) compared to the urban elderly who are treated aggressively to the end.

TABLE 10-18

COMMON STAGING DISEASE ASSIGNMENTS WITHIN DRGS BY HOSPITAL SIZE

DRG	Description	Disease Name and Number	Percent of Cases		
			Small Hospital	Medium Hospital	Large Hospital
<u>Cerebrovascular Disease Cluster</u>					
14	Specific Cerebrovascular Disorders Except TIA	Disease of Carotid Artery (251) Aneurysm of Cerebral Vessels (253) Disease of Vertebral Artery (254) Atrial Fibrillation (817) Essential Hypertension (829)	0.7% 4.0 86.0 1.7 6.8	0.6% 5.5 85.6 1.2 6.2	0.7% 6.0 86.3 0.7 5.4
15	Transient Ischemic Attacks	Disease of Carotid Artery (251) Disease of Basilar Artery (252) Disease of Vertebral Artery (254)	85.9 10.6 3.1	84.0 12.4 3.4	81.4 14.2 4.0
<u>Pneumonia Cluster</u>					
79	Respiratory Infections + Inflammation Age >69 and/or C.C.	Anaerobic Infections (411) Bacterial Pneumonia (504) Tuberculosis (514) Other Respiratory Conditions (590)	8.6 36.9 9.0 30.5	9.8 30.6 13.7 30.2	12.4 24.4 18.2 29.7
89	Simple Pneumonia + Pleurisy Age >69 and/or C.C.	Bacterial Pneumonia (504) Other Respiratory Conditions (590)	89.0 2.0	90.3 1.9	92.0 1.7
<u>Coronary Artery Disease Cluster</u>					
132	Atherosclerosis Age >69 and/or C.C.	Acute Myocardial Infarction (811) Atherosclerosis of Coronary Arteries (815)	0.1 87.8	0.1 94.7	0.2 93.8
140	Angina Pectoris	Atherosclerosis of Coronary Arteries (815)	99.8	99.4	99.6
<u>Prostate Disease Cluster</u>					
336	Transurethral Prostatectomy Age >69 and/or C.C.	Prostate Cancer (1001) Benign Prostatic Hypertrophy (1008)	24.6 72.0	24.0 73.2	23.2 73.8
346	Malignancy, Male Reproductive System, Age >69 and/or C.C.	Prostate Cancer (1001)	94.5	95.9	96.5

Source: Medicare Part A and Part B claims, 1982.

Note: Disease numbers based on Systemetrics staging algorithm.

TABLE 10-19
STAGING ASSIGNMENTS WITH THE MOST COMMON STAGED DISEASE CATEGORY BY HOSPITAL SIZE

DRG	Description	Disease Name and Number	Stage*	Percent of Cases		
				Small Hospital	Medium Hospital	Large Hospital
<u>Cerebrovascular Disease Cluster</u>						
14	Specific Cerebrovascular Disorders Except TIA	Disease of Vertebral Artery (254)	1	0.0%	0.0%	0.0%
			2	82.8	80.7	82.8
			3	0.1	0.2	0.1
			4	17.1	19.0	17.1
<u>Pneumonia Cluster</u>						
15	Transient Ischemic Attacks	Disease of Carotid Artery (251)	1	95.8%	96.3%	96.1%
			2	3.8	2.3	2.5
			3	0.1	0.0	0.0
			4	0.3	1.4	1.3
<u>Coronary Artery Disease Cluster</u>						
79	Respiratory Infections + Inflammation Age >69 and/or C.C.	Bacterial Pneumonia (504)	1	81.6%	72.5%	76.4%
			2	1.9	3.5	3.6
			3	3.9	1.8	1.4
			4	12.6	22.2	18.6
89	Simple Pneumonia + Pleurisy Age >69 and/or C.C.	Bacterial Pneumonia (504)	1	89.6%	83.7%	82.4%
			2	0.7	0.8	0.7
			3	0.6	0.7	0.6
			4	9.2	14.7	16.2
132	Atherosclerosis Age >69 and/or C.C.	Atherosclerosis of Coronary Arteries (815)	1	82.2%	85.5%	81.6%
			2	12.7	8.6	12.4
			3	0.5	0.1	0.1
			4	4.7	5.9	5.9
<u>Coronary Artery Disease Cluster</u>						
140	Angina Pectoris	Atherosclerosis of Coronary Arteries (815)	1	67.0%	65.3%	57.1%
			2	24.6	27.2	33.3
			3	8.1	6.6	8.4
			4	0.3	0.9	1.3
<u>Prostate Disease Cluster</u>						
336	Traurethral Prostatectomy Age >69 and/or C.C.	Benign Prostatic Hypertrophy (1008)	1	83.6%	90.8%	90.8%
			2	15.6	7.8	7.9
			3	0.6	0.8	0.6
			4	0.2	0.6	0.6
346	Malignancy, Male Reproductive System, Age >69 and/or C.C.	Prostate Cancer (1001)	1	66.0%	68.6%	66.7%
			2	1.0	0.7	0.6
			3	16.7	13.6	17.9
			4	16.3	17.2	14.7

*Staging for cerebrovascular and cardiac DRGs should be interpreted carefully in light of the limitations of staging. Many of the trends that appear to be significant are artificial, based on state specific coding practices rather than real differences in severity.

Bedsize Differences in Within-DRG Procedure Mix

The analysis of eight DRGs produces a clear and consistent finding: cases in small hospitals are least likely to receive services and procedures while those in large hospitals are generally most likely to receive services and procedures (see Table 10-20). These differences are most obvious with high cost, sophisticated, technologies.

Stroke (DRG 14) and TIA (DRG 15) offer the clearest examples of these trends. Head CTs were obtained in 1-in-2 of cases at large hospitals, compared to 1-in-4 at medium hospitals, and 1-in-25 at small hospitals. Use of the older, and less expensive technologies of skull x-rays and radionuclide brain scans was less frequent at large hospitals than at medium hospitals, although their use was lowest at small hospitals. For example, 17.3% of cases at medium hospitals received radionuclide brain scans compared to 11.8% at large hospitals and 9.3% at small hospitals. Thus, while medium hospitals more often appeared to use a substitute technology for CT, small hospitals appeared not to do so--small hospital stroke cases simply were less likely to receive either test.

TIA cases (DRG 15) display parallel findings regarding head CT, skull x-rays, and radionuclide brain scans. In addition, similar trends are found with the two most invasive and expensive technologic options. Nearly 1-in-5 large hospital cases received cerebral angiography compared to 1-in-10 medium hospital cases and 1-in-50 small hospital cases. Moreover, 1-in-7 large hospital cases received thoracic aortography compared to 1-in-20 medium hospital cases and 1-in-100 small hospital cases. Identical results are found for both stroke and TIA cases with regard to the specialized, but non-invasive and less expensive tests, echocardiography and electroencephalography (EEG).

In all of the CAD procedure options, small hospitals have the lowest frequency of use. Oddly enough, the service these "supposed" coronary artery disease cases were most likely to obtain was an upper gastrointestinal series, and only 7.3% of small hospital cases received even that test. Gastrointestinal series are common in medium and large hospitals as well, but the most common exam received by angina cases in large hospitals (DRG 140) is a radionuclide cardiac scan: 11.0% in large hospitals, 4.9% in medium hospitals, 1.3% in small hospitals.

TABLE 10-20

PROCEDURE DISTRIBUTION WITHIN DRGS BY HOSPITAL SIZE

DRG	Description	Procedure Name ^a	Percent of Cases		
			Small Hospital	Medium Hospital	Large Hospital
<u>Cerebrovascular Disease Cluster</u>					
14	Specific Cerebrovascular Disorders Except TIA	Head Cat	4.1%	27.6%	50.9%
		Skull x-ray	8.2	12.4	10.6
		Spine x-ray	1.3	2.6	3.5
		Thoracic Aortography	0.2	0.8	3.1
		Cerebro Angiography	0.2	2.8	5.1
		Radionuclide Scan	9.3	17.3	11.8
		Echocardiography	1.1	3.7	7.0
		EEG	1.4	6.4	10.6
		Lumbar Puncture	4.5	4.4	4.3
<u>Transient Ischemic Attacks</u>					
15		Head Cat	2.0	18.1	39.7
		Skull x-ray	7.5	14.5	11.0
		Spine x-ray	2.4	4.7	5.9
		Thoracic Aortography	1.0	5.1	13.7
		Cerebro Angiography	1.9	9.9	17.9
		Radionuclide Scan	9.6	21.1	17.0
		Echocardiography	1.4	3.7	7.7
		EEG	1.1	5.2	10.7
		Lumbar Puncture	0.8	1.7	1.9
<u>Pneumonia Cluster</u>					
79	Respiratory Infections + Inflammation Age >69 and/or C.C.	Bronchoscopy	2.9	9.2	13.1
		Chest x-rays	57.7	78.7	81.7
		Intubation ^b	1.8	3.5	2.6
		Radionuclide Scan	1.4	3.6	2.3
89	Simple Pneumonia + Pleurisy Age >69 and/or C.C.	Bronchoscopy	1.3	4.8	6.0
		Chest x-rays	56.7	75.2	80.1
		Intubation	0.6	1.5	1.6
		Radionuclide Scan	1.3	4.6	4.8
<u>Coronary Artery Disease Cluster</u>					
132	Atherosclerosis Age >69 and/or C.C.	Echocardiography	1.1	2.8	6.8
		Upper Gastro	5.3	9.7	10.4
		Cardiac Radionuclide Scans	0.8	3.4	8.3
		Abdomen x-rays	5.3	8.9	10.5
		Tolerance Test	0.5	1.2	2.7
		Gallbladder Study	1.9	3.5	3.5
		Holter	2.0	3.3	6.4
		Fiber Endoscopy	0.5	1.1	1.4

TABLE 10-20 (cont.)
PROCEDURE DISTRIBUTION WITHIN DRGS BY HOSPITAL SIZE

DRG	Description	Procedure Name ^a	Percent of Cases		
			Small Hospital	Medium Hospital	Large Hospital
<u>Coronary Artery Disease Cluster</u>					
140	Angina Pectoris	Echocardiography	1.3%	3.5%	7.2%
		Upper Gastro	7.3	10.3	11.0
		Cardiac Radionuclide Scans	1.3	4.9	11.0
		Abdomen x-rays	3.2	5.6	7.1
		Tolerance Test	1.2	2.3	3.1
		Gallbladder Study	2.8	4.7	4.6
		Holter	2.5	3.8	7.1
		Fiber Endoscopy	0.5	1.2	1.5
<u>Prostate Disease Cluster</u>					
336	Transurethral Prostatectomy Age >69 and/or C.C.	Cystrourethroscopy	18.7	20.0	23.2
		Needle Biopsy Prostate	1.6	2.6	3.6
		X-Ray Spine, Pelvis etc.	3.5	4.0	5.6
		X-ray abdomen	4.1	5.4	6.1
		Cystometrogram	5.5	2.4	3.9
		Ultrasound	2.1	3.8	5.8
		Urography	18.1	29.6	33.0
		Bone scan	5.9	11.1	14.1
346	Malignancy, Male Reproductive System, Age >69 and/or C.C.	Cystrourethroscopy	9.0	17.9	16.1
		Needle Biopsy Prostate	2.6	8.4	8.4
		X-Ray Spine, Pelvis etc.	11.3	15.5	20.6
		X-ray abdomen	7.1	10.5	12.4
		Cystometrogram	0.6	0.6	0.9
		Ultrasound	1.6	5.3	8.1
		Urography	6.8	15.2	15.8
		Bone scan	8.4	23.7	28.8

^aProcedures performed in less than one percent of cases were eliminated.

^bHospitals may not submit bills for intubation which is commonly performed by resident staff in teaching hospitals, therefore this figure may be an underestimate in hospitals with residents.

Source: Medicare Part A and Part B claims, 1982.

In general, procedures targeting CAD specifically are much more common in large hospitals than medium hospitals. For example, when compared to coronary atherosclerosis (DRG 132) cases in medium hospitals, those in large hospitals are 2.3 times more likely to receive echocardiography, 2.4 times more likely to receive a radionuclide cardiac scan, 2.3 times more likely to receive an exercise tolerance test, and nearly twice as likely to receive a Holter monitor. However, large hospital cases are only 30 percent more likely to receive fiberoptic gastrointestinal endoscopy, 20 percent more likely to receive abdominal x-rays, and 10 percent more likely to receive an upper GI series. Thus, while both medium and large hospitals pursue gastrointestinal work-ups at similar rates, the cardiac work-up at large hospitals is more common and technology-intensive than at medium hospitals.

The findings from prostatic disease and pneumonia merely confirm these trends. With one exception (cystometrogram in TURPs, DRG 336), small hospitals always offer the fewest services. Medium hospitals provide the most cystourethroscopy to prostate cancer cases (DRG 346), but otherwise large hospitals provide the most services to prostate cases (DRGs 336 and 346). Bronchoscopy is more common in large hospitals for pneumonia, DRG 89: 6.0% in large hospitals, 4.8% in medium hospitals, and 1.2% in small hospitals. In the more severe respiratory infection group (DRG 79), large hospitals also do more: 13.1% of their cases receive bronchoscopy, compared to 9.2% in medium hospitals, and 2.9% in small hospitals cases. Similar findings obtain for chest x-rays in DRG 79, with large hospitals providing more x-rays per user.

These results conform nicely with the findings from the casemix analysis reported above. Cases in small hospitals are older and may be less severely ill (they are less likely to die), while cases in large hospitals are younger and more severely ill. The paucity of services in small hospitals is consistent with a less aggressive, less technology-intensive approach towards extremely old individuals who are not hospitalized for a terminal event. The larger number of services and the greater technologic sophistication of the service mix at large hospitals may reflect a more activist posture towards relatively younger patients and those who are critically ill. Given these results, it may be possible to at least partially link the variations in practice patterns across these hospital types to a variation in casemix.

10.4 Stepwise Regression Results by Urban-Rural, Teaching, and Bedsize Strata

This section provides a stepwise regression analysis across three key hospital strata: Urban-rural, teaching-nonteaching, and bedsize. A stepwise regression method is used, entering the stratum of interest first, then controlling for other factors and covariates and measuring the change in costs by the key stratum. Instead of stepping in the HCFA wage index directly on the right-hand-side, the dependent cost variable was deflated by the index raised to the .8 power (see Methods section), then regressed on the urban dummy. This approach assured that the wage effect on the cost gap was not overstated due to collinearity with other explainors. Furthermore, state-specific dummies have been entered at the first stage to control for any unique differences in costs due to the four state sample. The nominal urban-rural cost coefficient is thus interpreted as the within-state average urban-rural difference.

10.4.1 Urban-Rural Cost Differences Explained

Table 10-21 gives the reduction in the urban-rural adjusted (by radiology-pathology-anesthesiology bills) Part A cost per admission with the stepwise inclusion of wages (W) through the routine per diem (RDIEM). The first figure at the top of each tracer U/R column provides a raw estimate of the average urban-rural nominal cost difference within-state, with no casemix or input price controls.* All coefficients have been transformed from logarithmic to arithmetic terms as described in the methods section.

Before any adjustments, the urban-rural cost differential in the four state sample was 57-67 percent for cardiac and cerebrovascular patients; 36 percent for pneumonia, and "only" 20 percent for prostate admissions. The initial R^2 's average roughly .08, implying that 8 percent of the total variation in observed costs per admission can be attributed to systematic differences in urban vs. rural hospitals.

Deflating nominal costs by $(W)^{.8}$ has a dramatic effect on the urban-rural cost coefficient. Cardiac and cerebrovascular U-R differences are reduced 27-29 percent; pneumonia differences, 39 percent; and for

*These percentage differences are not comparable to those shown on line 2 of the corresponding descriptive tables because the latter were wage index adjusted.

TABLE 10-21

STEPWISE CHANGES IN THE URBAN-RURAL COST DIFFERENTIAL BY DRG CLUSTER

Covariate	CARDIAC			CEREBROVASCULAR			PROSTATE			PNEUMONIA		
	U/R	Δ	R^2	U/R	Δ	R^2	U/R	Δ	R^2	U/R	Δ	R^2
URBAN	.678		.085	.573		.086	.196		.076	.357		.082
(W) ⁻⁸	.498	27%	.047	.405	29%	.045	.071	64%	.033	.216	39%	.038
DRG	.265	61	.303	.347	39	.166	.051	74	.152	.202	43	.057
SEV	.260	62	.311	.341	40	.172	.049	75	.177	.202	43	.068
PROCS	.083	88	.706	.051	91	.644	.048	76	.603	.039	89	.655
HOSP	.056	92	.653	.031	95	.653	.018	91	.622	.058	84	.668
ln(LOS)	.042	94	.849	.008*	99	.837	-.010*	100	.832	.025	93	.796
ln(RDIEM)	.038	94	.872	.018	97	.854	.004*	98	.861	.039	89	.819

*Statistically insignificant at the 5% probability level.

Δ = Cumulative percentage reduction in urban-rural gap.

Note: See text and Table 9-2 for variable definition.

prostate cases, fully 64 percent of the gap is explained by wage differences across urban and rural areas. Wage effects are relatively larger for prostate cases because the systematic urban-rural differences (unrelated to wages) are initially much less. The fall in the R^2 for each equation after deflation is consistent with the finding that U-R differences in per admission costs are less in real terms.

Controlling, next, for urban-rural differences in DRG mix, the gap narrows by just 4 percent for pneumonia cases; 10 percent for cerebrovascular and prostate; and a full 34 percent for cardiac cases (see A column). DRGs themselves are particularly limited in explaining variation in pneumonia costs per admission, as evidenced by the minimal increase in R^2 (from .038 to .057).

The failure of pneumonia DRGs to explain much of the raw variation in urban-rural costs can be due to (a) a lack of discriminatory power in the classification system itself, or (b) little systematic differences in DRG mix across urban and rural areas. Urban-rural pneumonia DRG mix differences were indeed trivial, as shown in Section 10.3.1 above. Such is not the case with cerebrovascular and prostate disease, however, where the R^2 rises over 10 points after controlling for DRG mix. Like pneumonia, these two clusters exhibit little systematic urban-rural mix difference, with the notable exception of DRG 5, extracranial vascular procedures, which are twice as frequent in urban areas (although still only 7.3 percent of urban cases in the cluster). Thus, major differences in mean DRG costs are significant in these two clusters in explaining the U-R gap, but lack of urban-rural variation in mix limits DRGs as a causal factor.

By contrast, DRG mix explains over one-third of the urban-rural difference among cardiac patients. DRGs 106 and 107, open heart surgery with and without catheterization, dominate the group. Not only are their costs 6-7 times those of DRG 143, chest pain, but their frequency in urban hospitals is roughly 10 times greater (see Section 10.3.1). DRG 125, circulatory disorders with catheterization, is about half as important as either DRG 106 or 107 in explaining urban-rural cost variation. Its cost difference is "only" about 60 percent more than chest pain, but its frequency is 5 times greater in urban areas.

Weighting each cluster by the relative frequency of admissions produces a crude average effect of DRG mix of roughly 18 percent on the urban-rural cost difference across all admissions. This is certainly an overestimate for all Medicare admissions. The heart cluster probably exhibits the sharpest urban-rural mix differences of any potential DRG cluster; it also has the greatest average cost range. These patients comprise almost 40 percent of our sample, a far greater percentage than among all Medicare admissions, giving disproportionate weight to an atypical set of illnesses.

Including the severity vector (SEV) after controlling for DRG mix makes almost no marginal contribution (less than 1 percent) to the urban-rural explanation. This is true even though many of the individual severity coefficients were quite significant. For example, patients with cardiac conduction disorders were 50 percent more expensive than the reference group of atherosclerosis stage 1 patients, holding wages constant. Yet CONDUCT's standardized regression coefficient was less (.049) than atherosclerosis stage 2's (.06), even though ATHERO2's absolute regression coefficient was only 1/4th as large. CONDUCT's limited effectiveness is clearly due to the fact that only 6 out of every 1,000 cardiac admissions exhibited conduction disorders vs. 160 per 1,000 with atherosclerosis stage 2. With such infrequent occurrence, any such severity indicator cannot play a large role in the urban-rural cost differential.

Would the limited explanatory power of severity persist if either DRG mix was not held constant in a prior stage? The answer is yes. Controlling for severity before DRG mix produces about a one percent reduction in the U-R differential in two tracers, cerebrovascular and pneumonia, while having a greater effect among prostate and cardiac cases, albeit still far less than DRG mix. Severity, for example, explains only 2.4 percent of the urban-rural gap among cardiac patients while DRG mix explains 34 percent.

Adjusting for procedure mix within DRGs, by contrast, explains far more of the urban-rural gap. For cardiac cases, the marginal effect over-and-above DRG mix, wages, and severity is 26 percentage points (88% - 62%); for cerebrovascular, 51 points; for prostate, only 1 point; and for pneumonia, 46 points. With the exception of prostate where most of the urban-rural difference is explained by just DRG mix and wages, procedure mix accounts for roughly 25-50 percent of the gross urban-rural difference. And this is clearly an underestimate as some of the procedure effect is already captured by the DRG mix effect.

Further controlling for the set of hospital characteristics (HOSP), including residents-per-bed, bedsize, scope of services, and specialty mix, appears to contribute little more to explaining the urban-rural gap--except prostate where they are 15 percent. This, of course, understates their role in that procedures, *inter alia*, have already been held constant. When just bedsize and residents-per-bed are included before procedure mix, the urban-rural gap is only about 4-7 points greater than if procedure mix is included as well. For the cardiac cluster, the difference falls from 26 percent to 13 percent, a 50 percent reduction in the unexplained urban-rural variance. This is about 3/4ths the effect of including procedure mix first. Bedsize and teaching status eliminates about 2/3rds of the remaining variance for cerebrovascular and pneumonia patients. Prostate is an exception in that procedure mix does little over-and-above hospital characteristics.

For pneumonia cases, the U-R gap widens again (actually, becomes less negative) when hospital characteristics are included in the model. While the explanation is complicated by the collinearity among included variables, what appears to cause the slight increase in the U-R gap is the bedsize effect. We know that urban hospitals are much larger than rural ones. Consequently, the bedsize effect on the U-R gap depends on whether bedsize by itself raises or lowers average costs *ceteris paribus*. For both cardiac and cerebrovascular cases, bedsize is indeed positive in the cost regression, thereby reducing the U-R gap when controlled for. For pneumonia cases, on the other hand, bedsize enters negatively, "adding" to the U-R gap once the larger, but seemingly "less costly", urban hospital mix is controlled for.

Adjusting next for length of stay appears to narrow the U-R gap slightly, although it significantly raises the overall R^2 . The small decrease implies that the other included variables have not completely captured differences in U-R mean stays. The small regression effect of LOS on U-R cost differences may understate its true effect to some unknown extent. Length of stay among cardiac patients, for example, is 17 percent longer in urban areas (9.5 vs. 8.1; see Section 10.3.1), but this is unadjusted for DRG mix. Yet, the small decrease in the U-R gap (from 5.6 to 4.2 percent) controlling for cardiac average LOS must be due to its positive association with other included covariates like procedure mix and bedsize.

If these characteristics lead to longer stays and not the other way around, we can conclude that a patient's LOS is not an independent explainor and should not be assigned much independent power in explaining urban-rural differences. If, on the other hand, patients are hospitalized longer because they are sicker, and DRG-severity mix does not adequately reflect this, then the LOS effect, as an additional severity indicator, is far larger than observed in the stepwise regression table.

As a final step, the hospital's own routine per diem was included, deflated by the area wage index. It thus stands as a proxy for routine nursing intensity, but may also include systematic differences in overhead costs as well, e.g., housekeeping, dietary. Considering the model a per diem one once length of stay is held constant, the reduction in unexplained costs from the prior step (LOS) can be interpreted as the routine per diem's effect on the variation in the overall per diem. The results suggest that about very little of the unexplained variation, after casemix and other ancillary procedures are held constant, can be ascribed to routine intensity. This, again, may be an underestimate of its total effect on per admission costs because some of its effect has already been reflected in the hospital's procedure mix, bedsize, and teaching status (as we show in more detail later).

Summarizing, all included variables, adjusted for unique state effects, explain 89-98 percent of the urban-rural cost difference across the four clusters. On a per admission basis (through the HOSP step), 84-95 of the U-R gap is explained. Area wages are generally the dominant explainor while DRG mix and severity together explain less than 20 percent of the urban-rural difference, with the major exception of cardiac cases where casemix explains over one third. Procedure mix is the second most important explainor, except in cardiac cases where DRG mix and wages already capture major urban-rural cost differences. Length of stay is found to be relatively unimportant after controlling for casemix and procedure mix across urban and rural areas.

10.4.2 The Impact of the Core-Ring Distinction on Urban-Rural Differences

Table 10-22 provides a similar stepwise approach to explaining the urban-rural differential, except that MSAs have been decomposed into core (large city), ring (around large cities), and other, small, MSAs. The first step includes only the core-ring-other MSA dummies, with the regression coefficients showing the arithmetic differences between the three urban groups and the all-rural group (in the intercept), holding nothing constant. As such, they show the degree of within-urban variation around the mean urban-rural difference given in the previous table. In the cardiac cluster, for example, the 68 percent U-R gap shown in Table 10-21 is comprised of a 91 percent large city core differential, a 38 percent suburban ring difference, and a 27 percent other-MSA difference. The core city-rural differential is far less across the other three clusters: 65 percent for cerebrovascular; 25 percent for prostate; and 46 percent for pneumonia disease.

Comparing R^2 's between the simple PPS urban-rural distinction and the trichotomous one shown in Table 10-22, the explanatory power of the finer-grained urban distinction is negligible except for cardiac cases. For that cluster, the R^2 rises from .085 to .111, a 30 percent improvement.

Adjusting, first, for urban-rural wage differences has roughly the same effect on all three urban groups, leaving their relative costliness unaffected. After controlling for the other basic PPS covariates, including DRG mix, teaching status, and bedsize, the core-ring-other-MSA differentials narrow considerably, but not completely (see the ln(TBED) line). For cardiac patients, the core city differential falls from 91 to 21 percent, or about 70 percentage points, while for cerebrovascular patients the decline is nearly as great, i.e., 65 to 15 percent, or 50 points. The decline is not nearly so dramatic for pneumonia, leaving a 16 percent core city-rural cost gap. For prostate cases, all of the core city-rural difference is explained. (It must be remembered that bedsize is being held constant as well, even though PPS makes no explicit payment adjustment for it. Furthermore, the DRG mix and resident-per-bed coefficients are not constrained to PPS levels.)

The effects of DRG mix, wages, teaching status, and bedsize on the ring and other-MSA hospitals is roughly the same as for core city hospitals, but because their differentials were much less to begin with, practically all

TABLE 10-22

STEPWISE CHANGES IN URBAN CORE-RING COST DIFFERENTIAL BY DRG CLUSTER

Covariate	CARDIAC				CEREBROVASCULAR				PROSTATE				PNEUMONIA			
	CORE	RING	OTHER MSA	R ²	CORE	RING	OTHER MSA	R ²	CORE	RING	OTHER MSA	R ²	CORE	RING	OTHER MSA	R ²
CORE	.907				.654				.245				.460			
RING		.379				.452				.088				.228		
OTHMSA			.270	.111			.391	.089			.031	.083			.202	.087
(W) ^{-B}	.710	.225	.161	.076	.485	.288	.262	.049	.118	-.033	-.060	.042	.315	.098	.100	.045
DRG	*				*				*				*			
ln(IRBED)	*				*				*				*			
ln(TBED)	.210	.079	.054	.321	.154	.095	.062	.194	-.019	-.068	-.060	.180	.155	.023**	-.028**	.088
SEV	.209	.076	.052	.330	.162	.094	.062	.200	-.017**	-.068	-.077	.205	.158	.022**	.027**	.099
PROCS	.101	.020	.057	.716	.059	.001**	.020	.653	.047	-.032	-.016**	.622	.117	.022	.083	.668
HOSP	.096	.022	.056	.718	.059	.005**	.021	.653	.054	-.027	-.015**	.624	.112	.022	.077	.670
ln(LOS)	.096	-.004**	.042	.851	.046	-.027	.015	.838	.013	-.046	-.010**	.834	.075	-.014**	.034	.800
ln(RDIEM)	.056	.024	.009**	.872	.026	.013	.000**	.854	.001**	.003**	-.021	.861	.057	.029	.025	.819

*Effects included in coefficients on ln(TBED) line.

**Coefficient insignificant at 5% confidence level.

their gap is explained. In fact, ring and other-MSA differentials turn negative for the prostate cluster. Even the core city-rural gap is negative for prostate. In other words, rural hospitals appear more expensive in treating these cases than in MSAs, once we adjust for DRG mix, bedsize, wages, and teaching status.

As before, controlling for severity does very little to explain the urban-rural difference. This is true even for the core city hospitals where one might hypothesize that within-DRG severity was most acute relative to other urban and rural hospitals.

The inclusion of procedure mix, by contrast, reduces the gap between rural and urban hospitals for all three urban groups, but only significantly for cardiac and cerebrovascular patients. The relative differences across urban groups remains about the same, with core city hospitals significantly more expensive than ring and other-MSA hospitals, even holding procedure mix constant inter alia.

Next, the HOSP line gives the cost difference on a per admission basis after additional hospital characteristics are controlled for while the LOS line essentially puts the difference on a per day basis. On either basis, big city core hospitals are significantly more expensive than their other urban counterparts.

Stepping in each hospital's deflated routine per diem last has the effect of reducing by one third the total per day cost gap not explained by the other variables. For cardiac patients, as an example, the unexplained 9.6 percent per diem cost difference falls to 5.6 percent for core-city hospitals. Thus, 40 percent of the per day cost differences unexplained by wages, DRG mix, ancillary procedures, etc. can be attributed to differences in routine intensity. Compared to the 91 percent U-R difference to begin with, the entire model explains over 90 percent of the gap, controlling also for the unique characteristics of our four state sample.

It is also interesting to compare the final R^2 's with the previous table, as they show the marginal explanatory power of our trichotomous urban variable. In fact, they are essentially identical, which suggests that unmeasured within-urban differences--particularly between large city cores and the other two groups--are being picked up by one or more variables in the dichotomous U-R model. A sharp large city core differential remains, nevertheless. This paradox is explained by a shift in intercept and slope, e.g., a higher core intercept coupled with, say, a lower teaching elasticity, that produces a similar R^2 .

10.4.2 Teaching-Nonteaching Cost Differences Explained

Table 10-23 presents stepwise regression results, in arithmetic terms, for the minor and major teaching vs. nonteaching cost differential. The first two lines, as before, represent the gross difference between teaching and nonteaching hospitals with nothing (except state) held constant. For cardiac patients, the raw difference between major teaching and nonteaching hospitals is 174.4 percent; for cerebrovascular patients, 126.8 percent; for pneumonia patients, 106.7 percent; and for prostate patients, "only" 62.9 percent. Minor teaching differences are consistently one-third as large as the major teaching differences across the four tracers.

Unlike the urban-rural results, controlling for wage costs does not significantly reduce the teaching-nonteaching cost difference; at most, 20 percent.

Holding DRG mix constant has only a marginal effect on the major teaching gap, with the notable exception of cardiac patients where the differences is halved to 71 percent. DRG mix has only a 20 percent marginal effect on cerebrovascular cases and less than 10 percent for pneumonia cases. The gap actually widens slightly for prostate cases, implying that major teaching hospitals are treating a relatively less costly DRG mix than nonteaching hospitals.

The major teaching cost gap remains several times the basic urban-rural gap even after holding both DRG mix and wages constant. The limited power of the wage index is no doubt attributable to the few teaching hospitals located in low wage, rural areas. Among cerebrovascular cases, for example, the U-R difference was 35 percent (Table 10-21, col. 4, line 3) while the

TABLE 10-23

STEPWISE CHANGES IN TEACHING COST DIFFERENTIAL BY DRG CLUSTER

Covariate	CARDIAC		CEREBROVASCULAR DISEASE		PROSTATE		PNEUMONIA	
	Minor Teach	Major Teach	Minor Teach	Major Teach	Minor Teach	Major Teach	Minor Teach	Major Teach
MIN TEACH	.537		.373		.184		.339	
MAJ TEACH		1.744		1.268		.629		1.067
(W)	.456	1.575	.307	1.102	.126	.497	.266	.902
DRG	.201	.714	.259	.905	.115	.515	.250	.835
SEV	.198	.699	.257	.890	.112	.522	.247	.837
PROCS	.107	.480	.107	.472	.099	.497	.096	.427
ln(TBED)	.119	.504	.123	.507	.123	.557	.153	.542
URBAN	*	*	*	*	*	*	*	*
HOSP	.117	.481	.120	.476	.139	.570	.149	.541
ln(LOS)	.138	.533	.112	.559	.121	.611	.163	.668
ln(RDIEM)	.047	.041	.053	.114	.054	.139	.072	.110

*Effects included in coefficients on ln(TBED) line.

major teaching-nonteaching difference is 90 percent (Table 10-21, line 4). Even prostate cases, which showed only a 5 percent U-R gap once DRG mix and wages were held constant, exhibit a 55 percent major teaching-nonteaching spread.

Although further severity adjustments did little for the underlying urban-rural difference, one might expect a greater effect across the teaching stratum. This clearly is not the case. Adding the vector of staging, age, and death covariates had less than a one point marginal effect on cardiac and cerebrovascular patients treated in major teaching hospitals and, like DRG mix, actually widens the gap slightly among prostate cases.

Adjusting, next, for procedure mix significantly reduces the major teaching-nonteaching gap for all but the prostate cluster. For cardiac patients, procedure mix contributes about 9 points, or 17 percent, to the small teaching difference, and 22 points, or 12 percent, to the major teaching gap. Its effects are even greater for cerebrovascular and pneumonia patients, averaging a third or more of the nominal cost gap. Nevertheless, almost 50 percent of the major teaching-non-teaching gap is unexplained by wages, casemix, or procedure mix.

Bedsize, in fact, has opposite effects on the teaching gap--particularly for pneumonia patients. Teaching status and bedsize exhibit a strong positive correlation (7 of the 11 major teaching hospitals are over 400 beds). For the teaching gap to rise, therefore, cases must be cheaper to treat in larger hospitals, holding teaching status, casemix, wages, and procedure mix constant (an important ceteris paribus). Apparently, this is not the case in large, major teaching institutions, as evidenced by the widening gap.

Controlling for the other hospital characteristics (i.e., service and specialty mix and urban location) explains little more of the major teaching differential. Surprisingly, the same is true for length of stay as well. Indeed, major teaching hospitals are far more expensive even adjusting for their casemix, procedure mix, longer lengths of stay, and urban/state location.

Controlling for the hospital's routine per diem (deflated) has a surprisingly large effect on the unexplained residual. The effect is about 10 points in minor teaching hospitals and 40-50 points in major teaching hospitals. Between one-third and one-half of the major teaching difference is thus attributable either to systematic teaching-nonteaching differences in routine care intensity or significantly greater overhead costs stepped down into the routine care department. The routine intensity effect is between 15-30 percent in minor teaching hospitals. These results confirm the descriptive findings from Table 10-9 indicating very large routine per diem differences by teaching status -- particularly in major teaching hospitals.

The overall model is quite successful in explaining teaching-nonteaching cost differences, but only after controlling for routine intensity. The power of the model is also much better for minor teaching hospitals that comprise the vast majority of all teaching hospitals (115 minor vs. only 12 major teaching in our sample). This suggests that previous work showing only limited differences between teaching and nonteaching institutions is not generalizable to major teaching institutions with very intensive residency programs.

10.4.3 Bedsize Cost Differences Explained

Finally, Table 10-24 presents similar stepwise reductions in the cost differential among the large and medium versus small bedsize groups. The gross differences are only half or less than those previously shown for major and minor teaching hospitals. For over-400 bed hospitals vs. less-than-100 bed hospitals, the range is from 23 percent (prostate) to 90 percent (cerebrovascular). The range between medium and small hospitals is much narrower: 2.9 percent (prostate) to 41.2 percent (cerebrovascular).

Wages explain little (15 percent) of the observed cost differences for cardiac cases in large hospitals, rising to nearly two-thirds for prostate cases.

As with the other tracers, controlling for DRG mix has only a limited effect except for cardiac patients. Nor does controlling for within-DRG severity explain any of the remaining gap.

TABLE 10-24

STEPWISE CHANGES IN THE BEDSIZE COST DIFFERENTIAL BY DRG CLUSTER

Covariate	CARDIAC		CEREBROVASCULAR		PROSTATE		PNEUMONIA	
	MHOSP	LGHOSP	MHOSP	LGHOSP	MHOSP	LGHOSP	MHOSP	LGHOSP
MHOSP	.235		.412		.029**		.120	
LGHOSP		.822		.897		.234		.442
(W) ⁻⁸	.223	.715	.350	.690	-.028**	.090	.078	.295
DRG	.136	.319	.295	.550	-.063	.046	.071	.281
SEV	.137	.318	.293	.543	-.065	.042	.068	.276
PROCS	-.073	.049	-.071	.039	-.115	-.006	-.094	-.005**
ln(IRBED)	-.083	-.042	-.082	-.046	-.035	-.113	-.110	-.106
URBAN	*	*	*	*	*	*	*	*
HOSP	-.089	-.051	-.066	-.028	-.131	-.108	-.102	-.095
ln(LOS)	-.100	-.082	-.060	-.064	-.019	-.126	-.108	-.117
ln(RDIEM)	-.019	.020	.005**	.024	-.048	-.020	-.042	-.027

*Effects included in coefficients on HOSP line.

**Not significant at 5% probability level.

MHOSP = 100-400 beds

LGHOSP = 400+ beds

Controlling next for procedure mix has a far more dramatic effect. For all four clusters, including cardiac cases, the bedsize cost gap is virtually eliminated. The absolute effect in large hospitals ranges from 30-50 points (excluding prostate), contributing 1/3-2/3 to the explanation. This is far higher than for major teaching vs. nonteaching hospitals. Teaching status would appear to have little effect over-and-above the procedure effect. Allowing procedures to vary by stepping IRBED in first, however, shows that teaching status proxies for procedure mix to a significant degree. For cardiac patients, the teaching variable picks up practically all of the procedure effect in large hospitals, for example.

Controlling next for systematic differences in lengths of stay by bedsize makes larger hospitals appear even less expensive on a per day basis--with the exception of medium-sized hospitals treating prostate patients. Routine per diems have no effect by bedsize, in distinct contrast to the large role they play in explaining the higher costs of teaching hospitals.

Unlike the teaching results, the stepwise regression model is capable of explaining away essentially all of the large-small hospital difference, regardless of disease. For prostate cases, it does so by controlling only for DRG mix, wages, and severity. For the cardiac and cerebrovascular cases, procedure mix must be held constant as well to eliminate any remaining cost differential. Apparently, large, over-400 bed, hospitals are so expensive, first, because they are disproportionately located in high wage cities, second, because they are more teaching oriented, and third, because their medical staffs perform significantly more procedures within-DRG. Excepting the special category of heart patients, their higher costs do not seem particularly dependent on a more costly DRG casemix.

10.5 Summary and Conclusions

The scope of this chapter does not lend itself to a brief summary of findings. For instance, we now know that the sources of cost differences vary in importance by tracer condition and type of hospital being compared. What is true for cardiac patients in urban vs. rural hospitals is not always applicable to prostate patients across teaching and nonteaching hospitals; in fact, it rarely is. Recognizing these differences, the summary and conclusions are presented by the three hospital comparisons separately.

Urban-Rural Cost Differences

Per admission differences between urban and rural hospitals vary by over a 7-to-1 range depending on illness, even after adjusting for area wage levels. Prostate cases are "only" 7 percent more expensive in urban areas while cardiac cases are 50 percent more so. Consequently, the relative contribution of identified sources of variation is not the same by illness. Some generalizations can be made, nonetheless.

First, adjusting costs by the 1981 HCFA wage index is clearly important in explaining cost variation, with roughly one-third of the nominal urban-rural difference attributable to this factor.

DRG casemix is of lesser significance, but important. Probably 10-15 percent of the observed cost gap can be explained by DRG mix, making a judgmental allowance for the overweighting of cardiac cases in the sample. DRG mix explains over one-third of the cost difference among the latter patients, due almost exclusively to the higher bypass surgery rate in urban areas. Only 1-in-142 rural cardiac patients receive heart bypasses vs. 1-in-8 in large core-city hospitals. DRG mix differences proved to be quite minor between urban and rural hospitals for prostate and pneumonia, suggesting either that casemix differences, in reality, are not all that great across urban and rural areas or that other-than-DRG casemix measures are necessary to capture true differences.

The limited effectiveness of DRG mix in narrowing urban-rural differences is also due, in part, to the lumping of core-city with suburban ring hospitals into a single MSA. Core city hospitals were found to have a disproportionately more expensive DRG mix, which PPS naturally adjusts for, while suburban hospitals looked much more like rural hospitals in terms of casemix.

Many additional severity indicators were tried, including the patient's age, whether the patient died in the hospital, and an extensive set of illness staging measures, but none contributed materially to the urban-rural cost differences within-DRG. If a major difference in casemix severity exists across urban and rural hospitals as a whole, we were unable to document it with the broad set of measures readily available from claims data.

What is actually done to each patient is obviously a critical determinant of cost. We found that casemix picks up a portion of the procedure mix difference, but usually far less than half. Whether ancillary intensity differences within-DRG were also systematically different in urban and rural areas was generally undocumented before this study. According to our estimates, differences in diagnostic and therapeutic procedures provided patients in rural vs. urban hospitals explained 25-50 percent of the inter-area cost difference (with the exception of prostate where they were trivial). Stroke patients, for example, were over twice as likely to receive a head CAT scan, thoracic aortography, cerebroangiography, echocardiography, and EEGs in urban hospitals. Again, these are procedural differences that cannot be attributed to DRG mix or to any of the other casemix indicators included in the analysis. All that can be said at this point in the research is that much of the ancillary intensity difference across urban and rural areas is attributable to the disproportionate number of large, often teaching, hospitals operating in urban areas.

Finally, patient lengths of stay and hospital routine per diems usually contributed much less than 10 percent to urban-rural cost differences, although they naturally explained a larger percentage of patient-specific differences.

Similar analyses that distinguished core-city from suburban-ring hospitals in the same MSA demonstrated that the former are often 2-3 times more expensive, even after adjusting for casemix, teaching status and bedsize. Nor did a finer wage index calculated separately on core-ring hospitals materially narrow the gap. Adjusting for procedure mix also had little impact on the within-urban cost differentials. The hospital's routine per diem, however, did have a significant effect in the core-city/suburban difference, suggesting either that inner city hospitals utilize nurses much more intensively than suburban hospitals or that major differences exist in the amount of overhead costs (e.g., administration,

laundry, housekeeping) that are stepped down into the routine cost center. Unfortunately, our data base was not disaggregated enough to discriminate between these two possibilities.

Teaching-Nonteaching Cost Differences

Cost differences between minor teaching vs. nonteaching hospitals are roughly equivalent to those observed for urban vs. rural hospitals generally; the gap between major teaching and nonteaching hospitals, by contrast, is far greater. Where minor teaching-nonteaching differences ranged from 18-54 percent depending on illness, the range for major teaching hospitals was between 63-175 percent. The major vs. minor teaching nominal cost difference within disease cluster was about 3-to-1.

Wage differences explained far less of the teaching-nonteaching cost gap, about 20 percent, than among urban and rural hospitals. This is to be expected given the preponderance of teaching hospitals in urban areas where wages are more similar than between urban and rural areas.

DRG mix had about the same average effect on the teaching-nonteaching difference, which is somewhat surprising. The range of impact was much greater, however. For prostate patients, DRG mix had no effect on the observed cost differences while at the other extreme DRG mix narrowed the cost gap among cardiac cases by over 50 percent. Ten to fifteen percent is probably a reasonable estimate of the DRG effect on teaching-nonteaching differences across all DRGs.

Additional severity adjustments made no discernable impact on the teaching cost gap once DRG mix was held constant; about 1 percent at most.

Procedure mix differences again play a central role in the cost model, explaining between 12-45 percent of the teaching-nonteaching cost difference (again with the exception of prostate where procedure mix played no role). Procedure mix also explained about the same proportion of the cost variance for major as well as minor teaching hospitals within disease cluster. Procedure mix had the largest effect with pneumonia patients, suggesting that teaching-based treatment patterns are most different for purely medical cases. Descriptive comparisons, for example, showed lab costs to be four times greater in major teaching institutions, and ICU and radiology costs, 3 times greater. Typically, a pneumonia patient will receive nearly 5 chest x-rays in a major teaching hospital per admission vs. only 3 in a nonteaching hospital, a 67 percent difference.

Bedsizes and other hospital characteristics contributed very little not already picked up by wages, casemix, and procedure mix.

The teaching hospital's routine per diem, however, made a major contribution to their costs, in sharp contrast to the urban-rural result. Between one-third and one-half of the major teaching cost differences are attributable to this factor while for minor teaching the effect is in the range of 15-30 percent depending on illness.

Bedsizes Cost Differences

Nominal cost differences by hospital size are not as great as by teaching status, but large, nonetheless. Compared to small, less-than-100 bed hospitals, medium-sized hospitals (100-400 beds) are 3-40 percent more expensive in nominal terms while large hospitals are 23-90 percent more costly. Cost differences between medium and large hospitals, on the other hand, are at least as large as between major and minor teaching institutions.

Wage effects on bedsize cost differences are surprisingly small, ranging from 5-10 percent for cardiac patients to over two-thirds in large hospitals treating prostate cases. One might have thought that the lower costs of small hospitals were attributable to their rural locational bias where labor costs are much less. Apparently, the significant number of small and medium sized hospitals found in MSAs where wages are comparable is an important offset. Naturally, wages are more important in explaining the costs of large hospitals, with effects ranging from 13 (cardiac) to 60 (prostate) percent.

DRG mix is also a minor factor in the bedsize cost gap, again with the notable exception of cardiac cases where it explains 40-50 percent of the small vs. medium or large hospital difference. Overall, DRG mix effects are similar to those found for urban-rural hospitals generally (about 5-15 percent), with lesser effects for medical conditions like pneumonia and much greater effects for conditions that can be treated surgically.

As before, the vector of other casemix and severity indicators explained none of the cost difference across hospitals of different sizes.

Procedure mix differences appeared to explain an even greater portion of the cost differences by hospital bedsize than by teaching status. Roughly

half of the observed cost difference in small vs. medium or large hospitals is explained by more intensive diagnosis and treatment patterns in the larger institutions. Much of this procedure difference effect, however, must be ascribed, not to size per se, but to the fact that a disproportionate number of large hospitals also have teaching programs (59 out of 69).

Finally, routine per diems in large hospitals added nothing to our understanding of the bedsize cost differences. This is very different from the role they played in explaining teaching cost differences. This is because large hospitals do not exhibit the discrepancy in routine per diems found between major teaching and nonteaching hospitals. Why major teaching routine costs per day are so much higher than average is still unknown, but are a likely combination of greater nursing intensity and more overhead costs associated with managing a diverse casemix being treated by residents as well as nurses.

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